Surveying and Mapping

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July – September 1951

Quarterly Journal

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The American Congress on Surveying and Mapping is a non-profit association, organized to advance the sciences of surveying and mapping in their several branches, in furtherance of the public welfare and in the interests of both those who use maps and surveys and those who make them. It aims to establish a central source of reference and union for its members, to contribute to public education in the use of surveys and maps, and to encourage the prosecution of basic surveying and mapping programs, especially those programs which are paid for, in whole or in part, with public funds.

Annual dues in the CONGRESS entitle members to all the privileges of the CONGRESS and to all its publications.

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BOX 470, BENJAMIN FRANKLIN STATION, WASHINGTON 4, D. C.

SURVEYING AND MAPPING

A. L. Shalowitz, *Editor-in-Chief*

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of Surveying and Mapping

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VISITING LADIES WERE ENTERTAINED AT A LUNCHEON ON FIRST DAY OF ELEVENTH ANNUAL MEETING

July • Aug. • Sept. • 1951

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President FitzGerald Opens Eleventh Annual Meeting

MEMBERS of the American Congress on Surveying and Mapping and guests: I have the honor and the privilege to open officially this, the Eleventh Annual Meeting of the American Congress on Surveying and Mapping. I extend to all of you a cordial welcome and an invitation to assist our Program Committee in making this meeting a success. I believe you will agree with me that they have already done more than their share, and it is now up to us to carry on.

Many of our out-of-town members and guests have traveled a great distance to join us today, and we are honored by their presence. The distinguished Surveyor General of New Zealand, Mr. R. G. Dick, this year accompanies our loyal delegation from Canada, who have always contributed so much to the success of our annual meetings. The Canadian Institute of Surveying and Photogrammetry is this year represented by Mr. James B. O'Neill.

Our neighbors to the south are represented by distinguished members from Mexico and Central and South America. Members from our sections and institution affiliates in Texas, California, New York, Georgia, Michigan, and Virginia are here in force.

We have a good program, a good crowd, and, of course, that is all we need to make this a traditional American Congress on Surveying and Mapping Annual Meeting.

The Program Committee has suggested that I keynote the Eleventh Annual Meeting. This hardly seems necessary, since our Program Committee, under Mr. Alfred Stiefel, has worked hard for many months to inform the world that surveys and maps are the basic blueprints for development and progress for peace and defense.

We are gathered here as representatives of our profession to review and

PRESIDENT GERALD FITZGERALD

evaluate the past year's accomplishments and to discuss ways and means not only to provide the basic blueprints but to ensure, if possible, that they are available and used when and where they are needed.

It is probably true that there are more people in this country engaged in surveying and mapping now than at any other time in our history, and generally they are better trained and better equipped. Government mapping agencies, State and Federal, are for the most part more than double their pre-war size. Commercial companies in the field are expanding rapidly and broadening their base of operations to include a wider variety of services in order to meet the in-

creasing demand for surveys and maps needed for industrial expansion and national defense.

Throughout the country the surveyor is finding new responsibilities and broader horizons. Progress, too, has been made in the development of new instruments and mapping and surveying techniques, as you have found out this morning by your preview of our exhibits. Technical education and training are receiving more attention and our new Education Division marks an important milestone in this respect.

In planning for the immediate future, the most important single factor is our defense program. We must prepare for any eventuality, and here the basic blueprints are an urgent necessity. This job may well tax the capacity of all our surveying and mapping resources. If and when the war clouds lift and scatter, we should be able to forge ahead at full speed toward the accomplishment of a national mapping program as proposed in H. R. 1636, which, by the way, is still being considered by Congress and on which hearings are scheduled for later this month.

In any event, for defense or for peace, we are prepared to provide the Nation's needed surveys and maps.

One of the principal, if not the most important, objectives of the American Congress on Surveying and Mapping is education. This is a field that in recent years has assumed an increasingly important role in Congress activities, and its recognition by the establishment of a new division is especially appropriate at this time. The appreciation and the use of good surveys and maps should become a part of our educational program. We may be good surveyors and mappers, but, obviously, in the past we have not been very good salesmen. There are far too few people, even in the engineering profession, who appreciate the work we are doing or can do. The proper use of existing surveys and maps unquestionably would save this Nation millions of dollars annually, while the making of new surveys and accurate maps in advance of costly construction projects would be a major economic blessing. Our Congress is becoming large enough and influential enough to spearhead this type of an educational program.

The first 6 months of 1951 have been active for the Congress and its members, and I will touch briefly on a few of the high lights of this activity. The membership is rapidly approaching the 2,500 mark. This includes a well-balanced distribution within the framework of our technical divisions. The unusually large increase this year did not just happen, but is largely the work of our untiring chairman of the Membership Committee, Capt. Frank S. Borden, and too few members of the Congress. We also have added several new sustaining members during recent months.

The technical divisions have been active during the past 6 months, both in strengthening their groups and in acquiring new members. Meetings have been held in Washington by the Cartography, Topography, and Control Surveys Divisions. A number of local meetings have also been held in California, Texas, Colorado, and Missouri. The Control Surveys Division has completed its standards for highway surveys; the Property Surveys Division is giving much thought and effort to the preparation of a land surveyors' handbook. The Topography Division has joined hands with the American Society of Photogrammetry to work out specifications for large-scale maps.

The Surveying and Mapping Instruments Division has been rather quiet during the past 6 months, but is probably, we hope, building up a head of

steam for this Eleventh Annual Meeting.

The new Education Division is now organized, and we are all looking forward with a great deal of interest to its program for the coming year.

One of the outstanding developments during the past few months has been a study and a recommendation by a special Publications Committee designed to provide more effective assistance to our Editor-in-Chief, Mr. A. L. Shalowitz, and at the same time, to ensure that the selection of material for publication in the Journal will be of interest to all our divisions. A new Publications Committee has recently been appointed, and Rear Admiral K. T. Adams has accepted the chairmanship. The Journal is so important to the Congress that its preparation and publication deserve continued supervision and support. We have set a high standard which, as a growing organization, we will have difficulty in maintaining on a volunteer basis, unless we have an adequate and capable Publications Committee and editorial staff. The acceptance of the chairmanship of the Publications Committee by Admiral Adams will do much, I believe, to ensure the type of publication we would like to have.

I would like to express now, on behalf of the officers and membership of the Congress, our appreciation for the magnificent job that our Annual Meeting Program Committee has performed and is performing. I do not know how many of you realize the tremendous amount of work necessary to put on this show. It takes time and effort and lots of it.

The program that follows I believe is one of the best we have ever attended. Certainly there is a lot of it. Because it is crowded, because we hope to encourage discussion from the floor, we are limiting rigidly the time of presentation of the papers to a 10-minute period, with a 10-minute discussion to follow. I hope you will join actively in this discussion, and, when you do, please go to the center of the aisle and up to the microphone you see there at the center table, and, very important, please announce your name before speaking.

The Congress, in order to avoid lengthy introductions on the part of the presiding officer and to cut down the time to a minimum, has prepared a "Who's Who" of the Congress in mimeographed form. If you do not have a copy, you can obtain one at the registration desk, or from Mr. Stiefel or Mr. Smart. Every member of the Congress or guest who appears on the program is listed in that publication, so we are not going to take very much time in introducing our speakers. I will now call on the first panel discussion.

* * *

Announcing

The Twelfth Annual Meeting

JUNE 11, 12, 13, 1952

Shoreham Hotel, Washington, D. C.

The Eleventh Annual Meeting

THE Eleventh Annual Meeting of the American Congress on Surveying and Mapping was held at the Shoreham Hotel in Washington, D. C., during the three days June 18, 19, and 20, 1951. The total registration was 663, and included many of our members and friends from Canada and Latin America. Thirty-one States and Territories and thirteen foreign countries were represented, the most distant being New Zealand and Thailand. All those who attended agreed that it was the finest Annual Meeting of the Congress to date, and if you are one of those members who was prevented from attending, why not start planning now to attend the Twelfth Annual Meeting.

The first morning was devoted to registration, viewing the exhibits, and renewing old acquaintances. The Board of Directors and Officers met at a luncheon and held a short business meeting.

Plenary Sessions

The Congress was officially opened at 2 : 00 p.m. Monday afternoon by President Gerald FitzGerald who welcomed the members and guests present and outlined briefly the activities of the Congress since the Tenth Anniversary Meeting.

At the plenary sessions and at the Technical Division meetings there were six panel discussions and many worthwhile and stimulating papers. Abstracts of most of these are published in this issue, and to mention them individually in this report of the meeting would be only repetitious.

After the President's opening remarks, he introduced Robert H. Randall, the first president of the Congress, who acted as moderator of a discussion panel on the subject "Duties and Obligations of the American Congress on Surveying and Mapping to its Members and the Profession."

A second panel, composed of the chairmen of the Technical Divisions, was then introduced to discuss the allied subject "Rights, Privileges, and Obligations of the Members of the American Congress on Surveying and Mapping." C. S. Maltby of the Geological Survey, chairman of the Topography Division, acted as moderator. The other members of the panel were Prof. Russell C. Brinker, of Virginia Polytechnic Institute, chairman of the newly organized Education Division; Robert J. Voskuil, chairman of the Cartography Division; W. B. Williams, County Surveyor from Grand Rapids, Mich., acting for W. C. Wattles, chairman of the Property Surveys Division; Lester C. Higbee, of W. & L. E. Gurley, Inc., chairman of the Surveying Instruments Division; and R. M. Wilson, of the Geological Survey, chairman of the Control Surveys Division.

During the last half of the afternoon, three papers of general interest were given, one of which is reported in the abstracts. Dr. George H. T. Kimble, Director of the American Geographical Society, described "The Role of Surveying and Mapping in Developing the Economy of Nations." He was followed by Brig. Gen. Herbert B. Loper, Chief of the Armed Forces Special Weapons Project, who spoke on "The Role of Surveying and Mapping in National Defense."

After each panel discussion and each paper there was a short period during which those in the audience had an opportunity to address questions to the panel members and the speakers. The practice was followed generally throughout the meeting and at times the following discussion became so interesting and so spirited that the presiding officer had to halt it in order to keep the program on schedule.

At the close of the Monday afternoon session the president appointed a Resolutions Committee composed of Maurice Delaney (Cartography), chairman; Capt. H. W. Hemple (Control Surveys); Sol A. Bauer (Property Surveys); W. L. Egy (Instruments); S. V. Griffith (Topography); and Paul Rice (Education); and a Tellers Committee composed of A. C. Kalbfleisch, chairman; Clarence Norris; and Julius A. Speert.

The first part of the Tuesday morning session was devoted to cartography papers of general interest, and was presided over by Robert J. Voskuil, chairman of the Cartography Division. Three papers were

given. Following Fowler W. Barker's paper entitled "A Planned Program of Resource Surveys," William E. Davies of the Geological Survey made the startling comment that, according to the definitions given in the paper, only two quadrangles in the United States could be considered to be completely and adequately mapped. These papers were followed by a panel discussion on "Map Appreciation and Use."

The latter part of Tuesday morning was devoted to control survey papers of general interest, R. M. Wilson, chairman of the Control Surveys Division, presiding. Three papers were given.

When the plenary session was resumed Tuesday afternoon, three property survey papers of general interest were first given, this part of the program being presided over by Ralph M. Berry, vice-chairman of the Property Surveys Division. The first paper on "Computational Shortcuts and Aids for the Land Surveyor" was given by Vernon D. George of the engineer firm of Seybolt and George. Mr. George explained some shortcut methods, developed by the partners, which are not commonly known by land surveyors. Following this, John S. Hale, a registered land surveyor and civil engineer of Staunton, Va., gave a paper entitled "Toward Better Land Surveys." The third paper of the series was "Resurveys of Original Grants in North Carolina and Other States of the Thirteen Original Colonies," by Grady S. Harrell, chairman of Land Surveyors of the National Council of State Boards of Engineering Examiners.

The mid-afternoon was devoted to papers related to Latin America, Dr. Andre Simonpietri, Department of State, presiding. The first speaker was Brig. Gen. Miguel A. Sanchez Lamego, Chief of the Comision Cartografia Militar, of Mexico City, who spoke in Spanish on "Cartography in Mexico." His remarks were very ably translated into English by Dr. Simonpietri. Then Jesus Francisco de Albear of the Instituto Cartografico Nacional de Cuba presented a paper in English entitled "Cartography in Cuba—A Saga of the Old and the New." The third paper was on "The River of Doubt and Brazil," presented by Claude F. Gilchrist, Jr., of the Aeronautical Chart and Information Service of the Air Force.

During the remainder of the afternoon three papers on surveying instruments were given, Lester C. Higbee, chairman of the Surveying Instruments Division, presiding. Carl W. Keuffel, president of Keuffel and Esser Company discussed "American Surveying and Mapping Equipment"; he was followed by A. M. Caesar, president of Henry Wild Surveying Instrument Company of America, Inc., who discussed "Continental European Surveying and Mapping Equipment"; and then D. R. Stanley, Jr., of the British firm of Hilgar and Watts, Ltd., reported on "English Surveying and Mapping Equipment."

The first part of Wednesday's session was devoted to three papers on surveying education, Prof. Russell C. Brinker, of V. P. I., chairman of the Educational Division, presiding.

Three papers having to do with the British Commonwealth followed, this part of the program being presided over by C. C. Lindsay of Montreal, Quebec (Mr. Lindsay is the American Congress on Surveying and Mapping National Advisor for Canada). F. Weldon Beatty, Surveyor-General of Ontario, gave a paper on "Mapping for the Development of Natural Resources in Ontario." J. B. O'Neill, of the Canadian Department of Mines and Technical Surveys, representing the Canadian Institute of Surveying and Photogrammetry, on behalf of the president of that organization, invited members of the Congress to attend the 45th Annual Meeting of the Institute to be held at Ottawa next February. Mr. O'Neill then gave a paper on "Winter Control Traverse Surveys in Northern Canada." He was followed by R. G. Dick, Surveyor-General of New Zealand, who spoke on "Surveying and Mapping, Down Under."

The last part of Wednesday morning was devoted to one paper and a panel discussion related to topographic mapping, the session being presided over by C. S. Maltby, chairman of the Topography Division.

After lunch, W. G. Stoneman, Department of State, presided over the international aspect of the program. Robert H.

THE BOARD OF DIRECTION HOLDS A LUNCHEON–BUSINESS MEETING

Left side (front to rear): G. FitzGerald, A. C. Stiefel, W. C. Crump, W. T. Pryor, W. O. Byrd, L. G. Simmons, F. S. Borden, M. Y. Poling, R. T. Evans. *Right side* (front to rear): W. S. Dix, M. S. Wright, K. T. Adams, A. W. Kendall, C. F. Fuesehsel, A. L. Shalowitz, S. A. Bauer, G. H. Harding.

PAST PRESIDENTS HOLD PANEL DISCUSSION

Left to right: Robert H. Randall, George D. Whitmore, Capt. Frank S. Borden, Marshall S. Wright, Sol A. Bauer.

Randall, Bureau of the Budget, spoke on "The Role of the Surveyor and Mapper in Promoting International Understanding and Good Will." He described what is being accomplished on an international scale and named the agencies that are contributing to these aims. He was followed by Dr. Henry G. Bennett, Administrator of the Technical Cooperation Administration of the Department of State, who reported on "Mapping and Surveying and the Point Four Program."

After the business meeting and a few words by the president-elect, and a few announcements, the 1951 annual meeting was declared adjourned.

Business Meeting

Following president FitzGerald's opening remarks, he announced that the Congress had awarded an Honorary Life Membership to Ned H. Sayford, who for many years had been Head of Maps and Surveys Division of the Tennessee Valley Authority and had actively supported the ACSM. Due to illness, Mr. Sayford was unable to attend, and W. S. Massa of the TVA received the certificate in his name.

Reports were then presented by the officers of the Congress and the committee chairmen. Capt. Frank S. Borden, chairman of the Membership Committee, reported that the membership of the Congress now exceeded 2,500 and he saw no limit to its potential membership. He reported that the Executive Committee of the Congress had voted to award to any member who was instrumental in obtaining 25 new members a citation and a suitable pin or other item of recognition. In conformity with this action he named Charles W. Buckey, Lloyd E. Marsden, and Vernon S. Seward, of the Geological Survey, as the first recipients of the award, stating that Mr. Buckey had obtained 42 new members, Mr. Marsden 104, and Mr. Seward 90. He also gave honorable mention to others who had been active in obtaining new members, but who had not accumulated 25 or the membership records did not specifically identify their efforts. Among these were G. W. Herzog and Wilson F. Daniell of Houston, Tex.; Harold J. Teas of Malverns, N.Y.; Sammel Gould, Jr., Mahoning County (Ohio) engineer; Raymond L. Moore of the Denver Geological Survey Office; Lt. Comdr. William F. Deane, Coast and Geodetic Survey; H. A. Waterfall of the Twelfth Naval District Public Works Office; John S. McCall, Army Map Service; and William T. Pryor, Bureau of Public Roads.

The treasurer of the Congress, Richard T. Evans of the Geological Survey, reported on the current financial status of the Congress and K. T. Adams, Budget and Finance Officer, reported that the financial health of the Congress was excellent and that the 1951 budget of the Congress was based on estimated operating income of $10,350 and estimated expenditures of $8,050 with an estimated surplus of $2,300. In connection with the budget he praised the work of Captain Borden's Membership Committee and, pointing out that dues and new members are the lifeblood of the Congress, urged all members to support the membership drive by getting more new members.

The retiring chairman of the Publications Committee, Helmuth Bay, reported that, after 3½ years as chairman, he requested President FitzGerald to appoint a new chairman and suggested that a review of the publication policies of the Congress be made. A committee was appointed and prepared a report which was accepted by the Board of Direction. Mr. Bay commented on the duties of the Publications Committee and urged the members of the Congress to submit articles for publication, and concluded by publicly thanking the members of his committee for their efforts and cooperation, naming Warren Crump, William Cude, R. E. Frierson, George Whitmore, A. O. Quinn, W. H. Simonson, Jacob Skop, A. A. Stanley, Arthur Striker, and H. W. Whitlock. He also expressed his pleasure in working with the Editor-in-Chief, A. L. Shalowitz.

The new chairman of the Publications Committee, Rear Admiral K. T. Adams, then named the members of the new committee. They are Capt. Frank S. Borden representing the Membership Committee, and one member to represent each technical division as follows: Arthur F. Striker

(Cartography), Morris M. Thompson (Topography), Dr. W. O. Byrd (Control), Capt. Raymond P. Eyman (Education), Lester C. Higbee (Instruments), and Gordon E. Ainsworth (Property Surveys); with A. L. Shalowitz, Editor, an ex-officio member. The chairman urged the members to cooperate with the members of the committee and to submit articles for SURVEYING AND MAPPING through their Technical Division representative. The chairman then reported the Publications Committee had agreed to act at once on one of the recommendations of the Committee's Special Report and announced that a new informal news-bulletin type of publication would be forthcoming, that Captain Borden had agreed to get this new publication started, and he pointed out that its success would depend on the support and contributions of the members.

President FitzGerald then called on A. L. Shalowitz, the Editor-in-Chief, who stated briefly that there was little an editor could report because the results of his efforts were the printed work in the Journal, which, good or bad, was evident to all. He expressed his thanks to Mr. Bay and his committee, to authors and contributors, and to others who cooperated in the preparation of the Journal for publication.

Helmuth Bay then reported as chairman of a Committee on Map Scales, which had been appointed as the result of a resolution passed at the Ninth Annual Meeting. Mr. Bay's complete report appears elsewhere in this issue.

President FitzGerald then called for the report of the Resolutions Committee. Chairman Maurice Delaney, Hydrographic Office, reported that the Resolutions Committee had considered 14 recommendations, a number of which were inappropriate, and recommended 5 resolutions for the consideration of the Congress. These were all adopted and are printed elsewhere in this issue.

The Tellers Committee then reported. Albert C. Kalbfleisch, Geological Survey, chairman, reported that 744 ballots had been received. He pointed out that interest in the ACSM is worldwide, inasmuch as ballots had been received from 19 foreign countries: 6 South American countries, 4 Central American and Caribbean countries, 4 European countries, 3 countries in Asia, 1 country in Africa, and Canada. The balloting resulted in the following elections for 1952:

Officers

George H. Harding, *President*
William T. Pryor, *Vice President*

Directors

(Two-Year Term)

Talbert Abrams, *Aerial Surveying*
Robert H. Lyddan, *Cartography*
Rear Admiral K. T. Adams, *General Mapping*
Elmer C. Houdlette, *Map Users*
Prof. Arthur J. McNair, *Education*
Prof. Arthur H. Robinson (For one year to complete W. T. Pryor's term)

President-Elect Harding was then introduced and in a few words he thanked the Congress for its expressed confidence in him.

President FitzGerald then announced the formation of the Texas Local Section since the last Annual Meeting, and called on G. W. Herzog, Shell Oil Co., who had been principally responsible for its formation, for a few words. Mr. Herzog simply reported the present membership of the Section and assured the Congress of the Section's future growth.

The Executive Committee's approval of a Northern California Local Section, contingent on a satisfactory constitution, was then announced.

After a few announcements, the business meeting adjourned.

Technical Division Meetings

The six Technical Divisions of the Congress held separate technical and business annual meetings simultaneously on Monday evening. The reports of these meetings follow:

CARTOGRAPHY DIVISION

The business meeting of the Technical Division on Cartography convened in the Terrace Banquet Room, with about 85 in

attendance. The chairman, Robert J. Voskuil, opened the meeting with a request from the Board of Direction of the Congress that individual members submit suggestions as to the type of program they would be interested in for the Twelfth Annual Meeting.

Mr. Crump, chairman of the Tellers Committee, reported that 78 ballots had been received from the membership. Gordon B. Littlepage was elected chairman of the Cartography Division for the calendar year 1952 by unanimous vote of the members, and Maurice S. A. Delaney, Robert L. Moravetz, and Dr. Walter W. Ristow, in that order, were elected to the Board of Direction of the Division.

The new chairman was introduced and he expressed his complete agreement with the aims and activities of the present Board of Direction and pledged continuance of those aims. He emphasized the importance of holding local meetings, extending the activities of the Division into the field, and the utilization of the Research and Development Committee as a medium for continuing the work started this year.

Mr. Delaney, chairman of the Technical Standards Committee, reported that his committee has been organized and a program designed to provide the membership with a comprehensive report of the various ways used by government and private map-making units to produce technical maps and charts. This is a cooperative venture to disseminate the many "short cuts" in techniques of compiling, drafting, and reproducing maps and charts.

Mr. Fuechsel, chairman of the Research and Development Committee, pointed out that his committee is conducting a survey among eminent cartographers in and outside of Washington on the "improvement activities" in the field of map making. A preliminary questionnaire has been prepared for circulation, and it is hoped that a comprehensive report can be made via SURVEYING AND MAPPING by the end of the year.

Mr. Dunich, chairman of the Membership Committee, reported that the Cartography Division is working closely with the Membership Committee of the Congress and has prepared leaflets and pamphlets which are available to individual members for use in recruiting new members. He indicated that the Division now has a membership of 170.

Mr. Davies, chairman of the Programs Committee, made no oral report, but Mr. Voskuil, in introducing him, paid tribute to his committee for their untiring efforts in developing programs for both the local Division Spring Meeting and for the Annual Meeting now in session. He also thanked the officers and the Board of Direction of the Division for their assistance and contributions in developing the present program of the Division.

The chairman then introduced the speaker of the evening, Mr. Aaron L. Shalowitz, of the U.S. Coast and Geodetic Survey, who presented a paper on "Cartography in the Submerged Lands Oil Cases" (published elsewhere in this issue). He pointed out some of the legal questions settled by the Court as well as the cartographic problems that will be encountered in delineating the line of demarcation between Federal and State jurisdiction along the California coast and offered possible solutions to the problems, depending on definitions to be determined by the Supreme Court.

The litigation now before the Supreme Court resulted in widespread interest in the paper and considerable discussion from the floor. Mr. Boggs, Department of State, pointed out the complexity of determining a formula for establishing a definite line mutually acceptable to both State and Federal governments.

The Honorable Everett W. Mattoon, Assistant Attorney General of California, congratulated the speaker on his presentation of an admittedly complex problem, but stated that, in his opinion, the paper oversimplified the legal aspects of the problem and he took issue with the formulas proposed for defining the limits of the areas in dispute.

Rear Admiral Colbert, retired Director of the Coast and Geodetic Survey, explained the origin of the international acceptance of the three-mile limit as the demarcation line between territorial waters and the high seas to have been based on the range of cannon fire in the early days and

pointed out the inadequacy of this line in view of modern concepts of coastal defense. He congratulated Mr. Shalowitz on the thoroughness and skill used in presenting the problems and recommended that the paper be published in an early issue of SURVEYING AND MAPPING.

A sound slidefilm, "Type and its Origin," was presented through the courtesy of Monsen and Company, Chicago, Ill. It was preceded by a short introduction by Myron Monsen, president of the Company.

TOPOGRAPHY DIVISION

Mr. Maltby, chairman of the Division, opened the meeting, which convened in the Main Ballroom, and welcomed the Division members and then introduced the first speaker, Vernon F. Reynolds, Aero Service Corporation of Philadelphia, who spoke on the subject "Automatic Profile by Radar Altimetry."

Mr. Speert, Geological Survey, elaborated on some parts of the paper. The Geological Survey in 1950 undertook to obtain by this method ground elevations throughout approximately 78,000 square miles in Central Alaska. In the original plans for the project, it was hoped that profiles could be obtained that would be suitable for controlling mile-to-the-inch maps with a contour interval of 100 feet in an area, where good Shoran-controlled vertical photography had been obtained by the Air Force in 1949. It was planned to fly these profiles, approximately 8 miles apart, across the photographic flight lines, so that the 8-mile distances between the profiles could be bridged by Multiplex. The control routes were to be flown 3 or more times. On each flight the elevations were to be determined for designated lakes, river crossings, and flat land areas. It was stipulated that the total spread of the 3 or more elevations determined for any feature should not exceed 20 feet; of 22 elevations so determined, all satisfied the requirement of 20 feet; the average spread of readings was 11 feet.

It was further stipulated that the average of the several elevations determined for each feature should check the ground survey determination within a tolerance of $\pm 10\sqrt{2M}$ feet, where M is the distance in miles from the nearest check point or start of a run. Of 14 elevations so checked, all were well within the limit. The maximum error was + 23 feet at a distance of 114 miles from the check point, where a tolerance of 31 feet was allowable; the average error, without regard to sign, was less than 10 feet.

It is too early to predict with certainty that future results will consistently be as good.

The second speaker introduced by Mr. Maltby was D. R. Stanley, Hilger and Watts, Ltd., London, who spoke on the "Development and Production of an Optical Reading Alidade."

Mr. Maltby stated that he had made some tests with these alidades and predicted that they will be well liked and used widely by topographers all over the United States.

Mr. Maltby then introduced Edward B. Barthold, Geological Survey, who presented views on "Supplemental Vertical Control Methods."

This paper caused a great many questions and comments, some of which are briefed below:

In reply to an inquiry by Mr. Coon, the speaker stated that in flat or rolling country with passable roads, the elevation meter has proved most successful; along rough roads, results are not quite so accurate.

Professor McNair of Cornell University reported that the University has conducted quite a few experiments with altimeters and has had very good results. Some lines have been run to 1-foot accuracy with the base barometers close to the lines run. The horizontal spread seems to be the limiting factor—with bases 160 miles apart the error accumulated rapidly. With bases spaced closely the error should not exceed 3 feet. Well-trained personnel, controlled procedures, careful instrument recording and reading, and good weather will produce excellent work.

Mr. Eliel reported that exceptionally bad meteorological conditions and unusual shape and configuration of the terrain—deep canyons—can result in exceptionally large errors; one university in the west conducted experiments where the wind blew up a canyon with steep walls and eleva-

tion reading changes as large as 1,000 feet per minute were recorded.

Messrs. Jones, Coon, Landen, and Lyddan, and Capt. O. S. Reading also commented.

Mr. Maltby introduced Emmett J. Coon, Denver Geological Survey Office, who talked about "Photo-Trig and Subtense Bar Control for Topographic Mapping."

Mr. Coon's paper provoked many questions and comments, some of which were as follows:

In reply to an inquiry from David Landen, the speaker stated that approximately 36 basic horizontal control points of one kind or another were needed in the average 15-minute quadrangle before photo-trig could be used. He made it clear that photo-trig cannot be performed without a basic control scheme and that, on the average, 4 to 6 of the stations should be primary stations and 30 should be secondary control.

B. G. Jones reported that the Coast Survey has done considerable photo-trig work in northwest Alaska with very good results. This work is tied to good triangulation and is a 4- to 5-mile spacing of the supplementary, or break-down, control. In reply to his inquiry Mr. Coon said that the Geological Survey has used the intersection method to some extent but is leary of it, and uses it only in areas of very rough terrain.

Mr. Herring of Wallace & Tiernan, Capt. O. S. Reading, Coast and Geodetic Survey, Mr. McCall, Army Map Service, and several others also commented on Mr. Coon's paper.

Mr. Maltby called on B. G. Jones, chairman of the Nominating Committee, to report on the election of officers. Mr. Jones reported that Mr. Maltby had been elected to the chairmanship for another year and that Ford Bartlett and S. V. Griffith had been elected directors to serve for 3 years.

Mr. Maltby then reported that the Division membership had grown from a total of 220 members on the rolls last year to a total of 481 members at this time. He particularly praised Lloyd E. Marsden of the Rolla Office of the U.S. Geological Survey and Vernon S. Seward of the San Francisco Office. The Sacramento Office has a very active group, meeting monthly to discuss surveying and mapping problems and new developments.

Approximately 65 members attended the Division Meeting.

CONTROL SURVEYS DIVISION

The Annual Meeting convened in the Louis Seize Room. With the very able chairman, R. M. Wilson, presiding, one of the most interesting and fruitful meetings ever held was attended by some 60 members and guests. Two distinguished guests from abroad, Dr. Jesus Francisco de Albear of Cuba and Dr. W. A. Heiskanen of Finland were introduced and welcomed.

Regular items of business and some committee reports were considered before beginning the technical program. These included the unanimous election of Capt. A. J. Hoskinson, Coast and Geodetic Survey, as chairman for the 3-year period, 1952–1954 inclusive; a report by Mr. Fuller of the Research and Development Committee that a valuable paper on tachyometry, which the committee hoped to publish, had been received from William Mussetter of Ohio State University; a brief report by the associate editor, Dr. Byrd, urging the membership to submit for publication papers concerning their work which might be of interest to others; and a resolution by Capt. Hemple endorsing the proposed Technical Standards for Highway Surveys developed by the Highway Technical Standards Committee under the chairmanship of Mr. Carpenter. Subsequently, this resolution was unanimously approved by the Division and referred to the Resolutions Committee of the Congress for appropriate action.

Dr. W. O. Byrd of Ohio State University led off the technical program with a paper entitled "The Modern Mission of Geodesy." Considerable discussion ensued concerning the novel suggestion for super-control points to control the triangulation systems. Discussants included Col. Hough, Capt. Garner, Mr. Whitten, Mr. Simmons, and Dr. Heiskanen.

The second and final item on the technical program was the comprehensive panel discussion of the Technical Standards for Highway Surveys, with J. C. Carpenter

of the Bureau of Public Roads as capable and energetic moderator. In addition to the moderator, the panel was composed of L. G. Simmons, Coast and Geodetic Survey; Floyd W. Hough, Army Map Service; Jon S. Beasley, Florida State Road Department; and H. D. Walker, Geological Survey. Mr. Houdlette and Mr. Pryor entered the discussion from the floor with many encouraging and helpful comments.

At the close of the panel discussion a vote of thanks to the Highway Standards Committee was extended by the Division for its most excellent and valuable contribution to the science of highway surveying.

EDUCATION DIVISION

The first technical session of the newly organized Education Division convened in the East Room, with Prof. Russell C. Brinker, chairman of the Division, presiding. About 30 members and guests were present.

Sol A. Bauer presented a paper on "The Education of the Land Surveyor—If and When." In discussing Mr. Bauer's paper, Prof. H. J. McFarlan, of the University of Michigan, expressed the opinion that the teaching of proper thinking is more important than the teaching of routine surveying practices.

A discussion panel followed on "What Preparation for Surveying is Missing in Engineering College Graduates." The panel members were: R. C. Brinker, Moderator, D. N. Huddle, J. K. Bailey, Frances M. Hanson, T. C. Finnie, W. G. Stoneman, and Frank Mirgain. Mr. Huddle called attention to the inadequacy of college training in astronomical observation, route survey methods, construction surveys, correction of errors in field surveys, care and adjustment of instruments, and photogrammetry. Mr. Bailey proposed that engineering colleges should seek to provide a good background in fundamental sciences rather than specialized technical training. He also recommended that advanced survey courses be given in the senior year to emphasize the importance of the general subject of surveying. Dr. Hanson discussed the importance of cultural as well as technical subjects to the engineering student. Mr. Finnie recommended that engineering colleges place more emphasis on practical engineering training, preparation in photogrammetry, and a better understanding of the different requirements for accuracy in engineering. Mr. Stoneman called for a more effective and systematic liaison between engineering schools and employers of survey personnel. Professor Mirgain pointed out that survey curricula in most colleges are hampered by the fact that salaries of survey instructors are usually so low that it is difficult to obtain qualified men.

The discussion continued with questions and comments from the floor. Most of the points raised were centered on the question of general versus specialized training. Participating in this discussion, in addition to the panel, were Professors Irish of Princeton University, McFarlan of the University of Michigan, McNair of Cornell University, Egner of Purdue University, and Weeden of Bucknell University.

No business meeting was held and the meeting was adjourned.

SURVEYING INSTRUMENTS DIVISION

The Annual Meeting of the Surveying Instruments Division convened in a suite of private rooms, with Lester C. Higbee, chairman of the Division, presiding.

A. C. Stiefel, Geological Survey, introduced a sound film entitled "Leveling for Topographic Mapping." This is the first of a series of training films prepared by the Geological Survey in collaboration with the Commission on Cartography of the Pan American Institute of Geography and History. The film was well received and A. C. Stiefel and C. H. Drown of the Geological Survey answered questions regarding the preparation and purpose of the film. Copies will be available at the Map Information Office of the Geological Survey.

The use of visual aids for instruction and training was discussed by the group and chairman Higbee reported excellent results from film strips describing the care, repair, and use of transits and levels. Mr. Drown reported that the use of instruction films covering survey instruments had reduced the training period from 20 to 13 weeks.

W. L. Egy of Brunson Instrument Co., and Chairman Higbee discussed the problems encountered by American survey instrument makers in supplying instruments to the various agencies of the United States Government. The need for performance specifications to describe the instrument requirements was stressed.

A resolution was made to the effect that members of the Topography, Control Surveys, and Property Surveys Divisions of the American Congress on Surveying and Mapping shall be requested to submit their particular requirements for survey instruments to the Surveying Instruments Division for the consideration of the instrument manufacturers.

The following officers were elected for the next calendar year: W. L. Egy, chairman; L. E. Demler, vice-chairman; and C. A. Thorpe, Jr., secretary.

PROPERTY SURVEYS DIVISION

A combined special meeting and election of officers featured the meeting which convened in the foyer of the Main Ballroom. A large and enthusiastic group filled the room nearly to overflowing, and gave voice to each and every motion put before the chair. The program for the evening was in direct response to a popular demand stemming from rump sessions of the 1950 meeting for open discussion on pertinent problems peculiar to the practice of land surveying, and was ably conducted by vice-chairman R. M. Berry.

The following officers for the year 1952 were elected unanimously by the members present: Ralph M. Berry, chairman; William B. Williams, vice-chairman; Robert L. McCammon, secretary-treasurer; Gordon E. Ainsworth, associate editor; and Sol A. Bauer and John P. Goggin, directors for 3 years.

The first item of business concerned the publication of a roster of the members belonging to this Division. After considerable discussion from the floor it was unanimously agreed that such a roster should be compiled based on a geographical distribution of the members, and to include the bylaws.

The proposed Surveyor's Handbook was given careful consideration and as a crystallization of the many comments and suggestions from the floor it was voted to appoint a Ways and Means Committee authorized to proceed with the project. Suggestions from chairman Wattles and Professor Mirgain were instrumental in forcing the issue, and direct comments and recommendations by Jack Goggin were incorporated in the final motion.

One of the most controversial topics of the evening concerned the relative obligations of land surveyors and abstracters with respect to boundary line definitions. It was finally decided to appoint a committee to investigate this matter and make a report at a later meeting.

Mr. Williams assumed the initiative in a general discussion of the feasibility of a committee to promote public relations. It was generally agreed that the public should be made more survey-conscious, and towards that end a motion was adopted to appoint such a committee.

After a short discussion concerning a proposed committee to contact public agencies with respect to the land surveyors' professional status and comments on the unrelated subject of wage scales for survey-party personnel, the meeting adjourned.

Social Activities

The Ladies Luncheon Monday noon in the Louis Seize Room was attended by about 40 members, wives of members, and guests. At this luncheon Miss Delia Goetz of the Office of Education, Federal Security Ageney, was guest speaker. The title of her talk was "An Introduction to Your Neighbors in Latin America."

An informal fellowship and coffee hour was held Monday morning on the Bird Cage Walk. Here old acquaintances were renewed and many members relaxed for a few moments before returning to view the instrument exhibit which was nearby in the West Ball Room.

The cocktail hour late Monday afternoon after adjournment of Monday's plenary session was another opportunity for relaxation and renewal of old acquaintances. In the opinion of most of those attending, it was much too short, because of the eve-

ning Technical Division meetings scheduled for 8 o'clock.

The Eleventh Annual Dinner on Tuesday evening in the Terrace Banquet Room was greatly enjoyed by the 207 members and guests attending. During the dinner, music was by the Candlelight Trio, well known to the members of the Congress from its previous appearances at these functions. There were no speeches. President FitzGerald greeted the guests and there were a few words from A. C. Stiefel, general chairman of the Annual Meeting.

After dinner a very attractive dance couple from the Arthur Murray Studios entertained the guests with exhibitions of the six or seven most popular current dances. These exhibition dances were followed by a challenge, accepted by Dr. Andre Simonpietri, Department of State, who danced the samba with Miss Beatriz Areila, a most attractive young lady from Caracas, Venezuela, who is in this country training in geodetic computations at the Coast and Geodetic Survey. Following that dance Alberto Castro, a young man from the Department of Public Works at Lima, Peru, danced an exhibition tango with Miss Areila.

After the Annual Dinner the diners transferred to the Main Ballroom for the Map Maker's Ball. The exhibition dance couple from Arthur Murray Studios who entertained at dinner mingled with the dancers, and the guests had an opportunity to compete with the experts.

The present and the newly elected officers of the Congress had an opportunity to become acquainted with one another and discuss mutual problems at a social and business dinner on Wednesday evening, after the close of the Congress.

Instrument Exhibit

The exhibit hall was officially opened at 10 a.m. on June 18. President FitzGerald commended the quality of the exhibits, thanked the exhibitors for their support, and requested the support of the exhibitors by the members of the Congress.

The exhibitors were then introduced by Ralph M. Berry, chairman, Commercial Exhibits Committee.

Contrary to past practice, no meetings were scheduled on the first morning, in order that members might give their undivided attention to the exhibits at this time. The Instrument and Equipment Exhibit was, as usual, one of the centers of great interest. Many of those in attendance came time and time again to see, handle, and examine in detail the numerous examples of surveying and drafting instruments and equipment as well as to view the various other miscellaneous cartographic and reproduction materials and the exhibits of photogrammetric and topographic services available under contract from private mapping concerns. The exhibit was much larger and broader in scope than in previous years and was particularly interesting and educational. The following 21 commercial concerns presented exhibits: engineering equipment and supplies, Eugene Dietzgen Co., Chicago, Ill.; precision aneroid altimeters, Wallace and Tiernan Products, Inc., Belleville, N. J.; surveying instruments, W. & L. E. Gurley, Troy, N. Y.; surveying instruments, engineering supplies, Keuffel and Esser Co., Hoboken, N. J.; engineering equipment and supplies, George F. Muth Co., Washington, D. C.; surveying and drafting instruments, Henry Wild Surveying Instruments Supply Co. of America, Inc., New York, N. Y.; Hilger and Watts Surveying Instruments represented by Jarrell-Ash Co., Boston, Mass.; surveying and drafting instruments, C. L. Berger and Sons, Inc., Boston, Mass., and New York, N. Y.; surveying instruments, David White Co., Milwaukee, Wis.; drafting and reproduction supplies, Federal Supply Co., Washington, D. C.; filotechnica salmoiraghi surveying instruments, Trans-Global Co., New York, N. Y.; surveying instruments, Brunson Instrument Co., Inc., Kansas City, Mo.; photogrammetric equipment, Zeiss-Aerotopograph, Munich, Germany; Zeiss-Opton surveying instruments, Carl Zeiss, Inc., New York, N. Y.; photogrammetric services, Photographic Survey Corp., Toronto, Canada; trans-adhesive map type, Monsen-Chicago, Inc., Chicago, Ill.; surveys and maps, Michael Baker Engineers, Rochester, Pa.; vinylite cartographic materials, N. Teitelbaum Sons, New York, N. Y.; aerial

surveys and maps, Aero Service Corp., Philadelphia, Pa.; steel surveyors stakes and brass caps, Bathey Manufacturing Co., Plymouth, Mich.; and tools for the graphic arts industry, Mark Specialty Co., Rochester, N. Y.

In addition to the commercial exhibits, a new optical theodolite manufactured by Keuffel and Esser Company for the Corps of Engineers was exhibited by the Engineer Research and Development Laboratories of Fort Belvoir, Va.

Federal Map Exhibit

One of the highlights of the Annual Meeting was the display, for the first time in the United States, of a special map exhibit illustrating the many mapping activities of the Federal Government. This exhibit was originally prepared for display at the Fourth Consultation of the Pan American Commission on Cartography held at Buenos Aires, Argentina. Since then it had been exhibited at Lisbon, Portugal; Paris, France; Rio de Janeiro, Brazil; and Santiago, Chile; but never heretofore in the United States.

The exhibit consists of 56 large panels illustrating the production of all types of maps and charts by the principal Federal Mapping agencies. The exhibit is arranged as a United States exhibit and consequently on a functional or typical basis, without any emphasis on a particular producing agency. All phases of field and office operations involved in the production of topographic and geologic maps, and nautical and aeronautical charts, including drafting and reproduction processes, are illustrated. The exhibit is an unusually comprehensive story of mapping in the United States.

Army Map Service Tour

Members had an opportunity on Thursday morning to inspect the Relief Map Division of the Army Map Service. The work of this unit had never before been publicly seen. Members went by bus from the Shoreham Hotel to the plant, where employees of the Division were on hand to illustrate and explain the development and present status of the design and production of terrain models in both rubber and plastic relief. Hundreds of these models can now be made in the time it took to make one a few years ago.

—K. T. Adams

* * *

Texas Section Meeting

As a forerunner to the Eleventh Annual Meeting of the American Congress on Surveying and Mapping, the Texas Section held its second meeting on May 28, 1951, at Hugh Wilkin's Armadillo Club. G. W. (Buck) Herzog of the Shell Oil Company, speaking before 57 surveyors and mappers and 12 visitors, said that the American Congress on Surveying and Mapping, with an international membership, was the principal outlet for surveyors in Canada and South America, as well as in the United States. Mr. Herzog, in giving a résumé of the Tenth Annual Meeting held last year in Washington, said that Ohio State University, in September 1950, became the first college to establish a course for conferring a degree in surveying and mapping. He spoke of the simplicity of surveying, as when determining heights of caves by tying strings to balloons and measuring the strings, as well as the complicated phase of surveying in the use of the electronic calculator in determining the trajectory of military missiles.

O. E. Young, Program Committee Chairman of the Texas Section, who presided, outlined the aims of the organization.

W. A. Rounds of Fort Worth, Chairman of the Legislature Committee of the Texas Surveyors Association, W. H. Wilson, and Ed. D. Morse discussed proposed changes in the laws governing State Licensed Land Surveyors.

—G. W. Herzog

Abstracts of Papers Presented at the Eleventh Annual Meeting

EDITOR'S NOTE.—These abstracts were prepared by the authors of the various papers. Titles and affiliations have been abbreviated in some cases. When the full papers are published in future issues of SURVEYING AND MAPPING they will include complete information on these items. Only abstracts that were submitted by the authors are included.

The Point Four Program

By DR. H. G. BENNETT
DEPARTMENT OF STATE

The paper deals largely with a description of the Point Four Program in its developmental work in the undeveloped countries throughout the world. This program, administered by the Department of State, provides technical aid in the form of expert consultants and demonstration and training equipment to all underdeveloped countries of the free world who request reasonable aid. Technicians are brought from the other countries to the United States for advanced training.

Assistance is given in the fields of (1) Agriculture and Natural Resources, (2) Industry and Government Services, and (3) Health and Education. In connection with the work required in these fields, numerous projects of aid in aerial photography and mapping are being undertaken throughout the world. Such projects are encouraged and are fundamental as the initial step in a sound co-ordinated approach to an overall developmental program of any area. In effect, surveys and maps provide the vital blueprint for planning such undertakings.

Point Four assistance is not accomplished entirely by the Federal Government; universities, private institutions, and private individuals all aid in it. Point Four assistance is not a gift; there must be some matching contributions from the requesting government and reasonable assurance that it will contribute to economic development and continue to be carried on in a self-sufficient manner after United States aid has been withdrawn.

Duties and Obligations of the Congress

(A PANEL DISCUSSION)

Mr. Robert H. Randall, first president of the Congress, introduced the panel and the topic, relating briefly the history of the origin of the Congress and emphasizing its purpose to bring together and to serve those who use surveys and maps and those who make them. Mr. Randall paid tribute to Prof. John S. Dodds, the deceased second president of the Congress, and introduced Mr. George D. Whitmore, the third president. Mr. Whitmore gave his views as to the function of the Congress as a dwelling and a meeting place for the cartographic profession. He was followed by Capt. Frank S. Borden, the fourth president. Captain Borden, who is now chairman of the Congress's Membership Committee, spoke of the new members and what they want the Congress to be. Mr. Marshall Wright, the fifth president, discussed the needs of institutional, as well as individual members. Mr. S. A. Bauer, the sixth president, spoke on the interests of the property surveyor, and told how the Congress can and does serve him. Mr. Randall closed the panel discussion, and emphasized that the Congress is *American* by original intent, with active members not only in the United States, but in Canada and the other American Republics. He then solicited questions on this subject from the audience.

A Planned Program of Resource Surveys

By FOWLER W. BARKER
U.S. DEPARTMENT OF COMMERCE

The recent expansion of American participation in the development of foreign areas has brought with it the responsibility of determining their economic and natural resource potentials. The information on which these surveys are based is primarily

cartographic in nature. The program must provide a large number of geologic, soil, hydrologic, and similar maps, in addition to topographic maps.

Three planning stages are necessary in a planned program: the preliminary stage, in which all available data are collected and analyzed; the reconnaissance stage, in which a general appraisal of the area is made from aerial photographs and related surveys made expressly for the investigation; and the appraisal stage, in which detailed inventories are made of developable resources by using aerial photographs and airborne geophysical instruments. This order is followed regardless of the nature of the area. Following these three stages is the construction stage, in which plans for the development of transportation, industries, and power plants are carried out.

Surveying and Mapping, Down Under

By R. G. DICK

SURVEYOR–GENERAL, DOMINION OF NEW ZEALAND

This paper traces the development of the profession of land surveying in New Zealand from pioneer days to the present. The subject is introduced with salient data concerning physical features, climatic conditions, and population and production. The early history of New Zealand is outlined briefly.

The history of surveying began with the coming of organized settlements in 1840, when a group of surveyors arrived in New Zealand to survey the lands of the New Zealand Company. The charter of 1840, erecting the colony of New Zealand, was accompanied by Land Survey Instructions. Survey operations of the New Zealand Company and of the General Government are summarized separately.

The qualification of surveyors is a function of the New Zealand Survey Board. The New Zealand Institute of Surveyors, a professional association, was established in 1888. The Surveyors Act of 1938 incorporated all practicing surveyors into the membership of the New Zealand Institute of Surveyors, and provided for the regulation of surveying practices.

Reciprocity in qualification of the surveyor has been established between New Zealand and the Australian states. Similar reciprocity with other States of the British Commonwealth has been proposed, but never implemented.

Map Appreciation and Use

(A PANEL DISCUSSION)

One of the foremost problems facing the profession of surveying and mapping is to develop map and survey appreciation and use. An enormous group of potential users of maps and surveys would benefit greatly by using them, but they do not understand their value, how to use them, or how to get them. Untold millions of dollars and much potential efficiency are wasted each year because many people who really need maps and surveys are not properly using the ones even now available.

To discharge fully their responsibility to the public, governmental mapping agencies should rectify this situation.

Commercial mapping agencies will get more business if maps and their uses are better understood.

To accomplish either of its two objectives in Article I of its constitution, the American Congress on Surveying and Mapping must do something about this, and specific recommendations for action by it are given.

A prepared panel discussion was conducted on the above problem by representatives of the major mapping groups. Mr. Walter G. Stoneman, Department of State, acted as moderator, and the others on the panel were: Col. Herbert M. Milwit, Joint Chiefs of Staff; Dr. Andre Simonpietri, Department of State; Mr. Arthur Lundahl, Navy Photo Interpretation Center; Mr. Fred Doyle, Syracuse University; Mr. Leon T. Eliel, Fairchild Aerial Surveys; and Mr. Phil M. Miles, Kentucky Agricultural and Industrial Development Board. In addition to comments and discussions original with the participants, a summary was given of the comments received from a wide variety of individuals and organizations. These comments were obtained in response to a circular letter sent to about 100 selected individuals and organizations.

Interpretive Cartography

By WILLIAM E. DAVIES
U.S. GEOLOGICAL SURVEY

Interpretive cartography is one of the more recent developments in American map-making. It is primarily a medium for expressing scientific or technical data in interpretive form that is understandable by the untrained user. In designing interpretive maps, the specific use or purpose of the map is of major importance as a number of interpretations are possible for each item of factual data. In addition, the form of interpretation depends on the scientific and technical training of the prospective user.

Interpretive cartography finds expression today in many forms; in propaganda and advertising, as well as in science and technology, it is used to convey to the layman information in an interpreted form that is easily understood.

Cartographic International Boundary Problems

By ARTHUR R. HALL
U.S. GOVERNMENT GEOGRAPHER

Many international boundaries, or limits of national administration, today are disputed or not recognized as final by various interested governments. The paper discusses the cartographic problem presented by such boundaries and suggests methods of presentation which will show the facts of actual control on the ground and at the same time indicate the uncertain nature of the boundaries.

The various types of boundary problems are illustrated by examples. Examples of situations not recognized as final by the United States Government are certain boundaries of Poland and the Baltic States. The armistice demarcation lines between Israel and the Arab States are discussed as examples of the uncertain limits of newly created states. There are boundary disputes of long standing, of which the Nicaragua-Honduras boundary is an instance. The India-China border in the Himalayas is an example of an indefinite or non-existent boundary.

Finally, reference is made to the representation of conventional limits and other lines on the high seas. Such lines cannot be considered as true boundaries.

Cartography in the Submerged Lands Oil Cases

By A. L. SHALOWITZ
U.S. COAST AND GEODETIC SURVEY

The paper discusses the Supreme Court decision of June 23, 1947, in which the Court declared that the United States and not California has paramount rights in the marginal belt off the coast of California for a distance of 3 nautical miles seaward of the ordinary low-water mark and outside of the inland waters of the State. It points out that the decision does not involve the tidelands nor the submerged lands under inland waters, but is limited to submerged lands beyond the inland waters of the State, dispute over which was presented to the Court for the first time. The decision poses a number of cartographic problems, particularly as it pertains to the determination of the seaward limit of inland waters and the actual demarcation of the State-Federal boundary. Criteria for establishing the inshore and offshore limits of the marginal sea are discussed.

(The complete paper appears elsewhere in this issue.—ED.)

Role of Gravity in Geodesy

By DR. W. A. HEISKANEN
CONSULTANT, OHIO STATE UNIVERSITY

The size of the earth ellipsoid can be determined by measuring meridional arcs. The best way to obtain the *shape* of this ellipsoid as well as the *undulations* of the geoid is the gravimetric method. Gravity anomalies enable us to determine the flattening of the earth ellipsoid with an accuracy of about 1 : 20,000; the geoid undulations with an accuracy of about 2 to 5 meters and the absolute deflections of the vertical with an accuracy of about 0.5 to 1.0 inch. We can convert the astronomic positions (latitude, longitude, and azimuth), from the geoid to the ellipsoid by subtracting the deflections of the vertical

components from them. As the accuracy of the astronomic measurements is about 0.3 to 0.7 inch, and the accuracy of the gravimetric deflection of the vertical components about 0.5 to 1.0 inch, we can get by astro-gravimetric methods the control points on the reference ellipsoid with an accuracy of about 30 to 40 meters, which is sufficient to *control maps* at scales of 1 : 100,000 and smaller. Besides, the obtained accuracy will not diminish with the distance of the control points, as it does in triangulation and traverses. Gravity anomalies, wisely analyzed, can also be used in establishing a *World Geodetic System* and in *converting* existing systems to this general system. Even the dimensions of the used reference ellipsoid can be corrected.

Because of these reasons the Mapping and Charting Research Laboratory of Ohio State University has planned a world-wide gravity program.

Control Surveys in Alaska

By CAPT. A. J. HOSKINSON
U.S. COAST AND GEODETIC SURVEY

This paper describes recent activities of the Coast and Geodetic Survey in extending control surveys in Alaska.

The chief subjects discussed are: Types of marks established; permanence of marks; methods of transportation, including fixed wing airplanes, helicopters, weasels, etc.; living conditions and personnel problems; working season and progress with respect to other areas where climatic conditions are better.

Modern Mission of Geodesy

By PROF. W. O. BYRD
OHIO STATE UNIVERSITY

Foundation control must precede mapping which in turn must precede developmental progress—this is the geodetic criterion of precedence and durability.

To gain proper perspective, the three eras of geodesy—spherical, spheroidal, and geoidal—are quickly delineated.

The modern geodetic mission is twofold: the determination of the size and shape of the geoid, and the determination of the physical surface of the earth with respect to the geoid.

In order to accomplish this mission all the powerful tools in our geodetic tool kit must be utilized to the fullest. Geodesists of the stature of Hayford are necessary to lead us forward.

Winter Traverse in Canada

By JAMES B. O'NEILL
DEPARTMENT OF MINES & TECHNICAL SURVEYS, CANADA

The paper is a descriptive outline of the operation of a winter traverse in northern Canada, with particular emphasis on the dog-team method of travel.

Organization, administration, and transportation are the salient features stressed, with a very brief outline of the actual survey involved. The technical details of the survey are intentionally omitted.

A general description of the terrain in the area, and a few anecdotes of the experiences of the survey party are included.

Control Surveys for Chesapeake Bay Bridge

By C. L. YOUNG
SURVEY ENGINEER, J. E. GREINER COMPANY

This paper explains the scheme of triangulation on the two shores of Chesapeake Bay and the methods used to establish and check control stations in the bay so that work could start on all contracts simultaneously. Methods for transferring levels across the bay before construction and the later check are also described.

(The complete paper appears elsewhere in this issue.—ED.)

British Surveying Instruments

By D. R. STANLEY, JR.
HILGER & WATTS, LTD., LONDON

British instrument making dates back to the early needs of the sailors and navigators. Ramsden's hand-operated dividing engine, constructed in 1777, made possible the first accurate sextants and theodolites.

The first automatic dividing engine was produced by Simms in 1826. Early surveying instruments were large and clumsy, but English manufacturers continually improved the design.

The success of the Zeiss optical theodolite in the early 1920's stimulated British production of optical-reading instruments. The Tavistock theodolite, brought out in 1926, gave optically meaned readings to 1 second in an entirely new manner. About the same time, Watts acquired a Zeiss license and produced the monocular micrometer theodolite.

World War II halted new developments. Since the war, Watts has produced the 1-second reading microptic theodolite which has a new method of graduation and of meaning the optical readings, giving more precise results.

New instrument designs are based on the extensive use of aluminum alloys, hardened parallel steel axes, and glass scales. British manufacturers are adopting techniques similar to American practices in using pressure die castings, stamping, and interchangeable parts. Further instruments are now on the drawing board.

The Microptic Alidade

By D. R. STANLEY, JR.
HILGER & WATTS, LTD., LONDON

Up to the time of World War II, telescopic alidades were equipped with the normal silver arc and vernier and the Beaman Stadia arc. The microptic alidade was designed to provide easily read glass scales, light weight, and convenience in carrying.

The alidade consists of three main units: (1) the blade; (2) the vertical pillar, axis and circle; and (3) the telescope and circle reading microscope. These units are described in detail in the paper.

The instrument weighs only 4½ pounds and is packed in a case with carrying strap, so that it can be carried on the arm and yet leave the hand free.

The instrument has been subjected to severe tests by the U.S. Geological Survey, and has performed well. A prototype model including some suggested modifications. has been produced according to Geological Survey specifications.

Supplemental Control Methods

By EDWARD B. BARTHOLD
U.S. GEOLOGICAL SURVEY

This paper reviews and evaluates various means of supplementing vertical control for areas to be mapped by photogrammetric methods. The term "supplemental control," as used herein, includes vertical control in addition to basic levels of third-order accuracy or better.

Modern methods of photogrammetric mapping have necessitated extending supplemental control of high accuracy for photogrammetric compilation. The Geological Survey is now engaged in trying various methods, either singly or in combination, in an attempt to determine the best and most economical procedures for establishing supplemental control in areas having various degrees of relief. It appears that no one method of determining supplemental elevations is ideal for all conditions encountered.

The solution, therefore, appears to be a matter of individually analyzing each area in order to plan and select the most appropriate method for obtaining particular elevations called for by the office photogrammetrist.

The advantages and limitations of some of the methods now in use or on trial by the Geological Survey are considered in this paper.

Photo-Trig and Subtense Bar Control

By EMMETT J. COON
U.S. GEOLOGICAL SURVEY

Conventional methods of surveying are commonly used to determine elevations for supplemental control of photographs to be used in map compilation. This paper discusses attempts to develop other methods to fit circumstances where shortcuts may be employed without loss of the required accuracy. Photo-trig is a procedure for measuring vertical angles, in the field, between points identified on the photographs,

starting from and tying to previously established elevations. Horizontal distances used in computing elevation differences with the vertical angles are obtained later from the planimetric base. The subtense bar is being used in connection with subtense base traverse in the Rocky Mountain Region.

Mapping Along National Inter-State Highway System

(A PANEL DISCUSSION)

The National System of Interstate Highways authorized by the Federal-Aid Highway Act of 1944 includes 38,000 miles of the nation's principal highways. It will serve 182 of the 199 cities in the United States with a population of 50,000 or more. The development of highways in the area served by this system is a long-range engineering project which requires that the best type of topographic maps be available for location, design, construction, and maintenance studies. A panel discussed ways and means of producing the required maps.

Mr. J. C. Carpenter of the Bureau of Public Roads opened the discussion and acted as moderator. Participating in the discussion were Capt. H. W. Hemple, Chief, Division of Geodesy, U.S. Coast and Geodetic Survey; Col. J. G. Ladd, Commanding Officer, Army Map Service, Department of the Army; Mr. R. H. Lyddan, Chief, Plans and Coordination Branch, U.S. Geological Survey; and Mr. H. F. Clemmer, Materials Engineer, District of Columbia, representing the American Association of State Highway Officials.

Automatic Profile by Radar Altimetry

By VERNON F. REYNOLDS
AERO SERVICE CORPORATION

A brief history of radar and radio altimeters is given, pointing out the limitations of past altimeters for topographic applications. A new development consists of a narrow-beam continuously recording radar altimeter, with automatic height correction features. Results of a field test of this instrument and its applications to mapping problems are described.

New Concepts for Topographic Mapping

By JAMES A. PATTERSON
PENNSYLVANIA STATE PLANNING BOARD

To have a satisfactory United States topographic mapping program, we must educate the average American in the language of maps and how to use them. Maps must be designed for use by the layman, rather than the technician, and they must be presented in a manner that will be understood.

The public must be trained to understand the surface of the earth and the forces which are continually changing it. They must be instructed in the language of maps so they know how the land they use fits into the larger pattern. Only then can they learn the principles of conservation, that they may better protect our natural resources.

Although great demands have been made to accelerate the topographic mapping of the United States, progress has been disappointing. State and Federal planning, conservation movements, and national defense have increased topographic map coverage from 47 percent in 1934 to 50 percent today.

The larger development areas such as the Tennessee Valley Authority and the Missouri River Development projects have temporarily diverted mapping facilities from other sections.

New developments and improved techniques have accelerated the mapping programs, but such factors as too close association with allied special purpose mapping, and inadequate facilities for the distribution of topographic maps tend to restrict the expansion of the program.

Visual education in the form of displays, plastic models, film strips, motion pictures, radio, and the press, can all be used to teach the language of maps to the public, and the American Congress on Surveying and Mapping is the logical organization to promote and direct a program to achieve this goal.

Objectives of Education Division

By PROF. PAUL P. RICE
RUTGERS UNIVERSITY

The paper describes the impetus given the American Congress on Surveying and Mapping in its early days by leaders in Committee 8, Surveying and Mapping, American Society for Engineering Education; and discusses the objectives and work of the Education Division and how they tie in with the work of the American Society for Engineering Education.

Refresher Courses for Surveyors

By MAJ. S. W. DOBYNS
VIRGINIA MILITARY INSTITUTE

The paper describes the content of the short refresher courses in surveying given at the Virginia Military Institute in 1950 and 1951 and the value of such courses and need for continuing and expanding their scope.

Higher Surveying and Photogrammetry Instruction

By PROF. CARL A. EGNER
PURDUE UNIVERSITY

The paper deals with the attempt to translate a lifetime of experience in Coast and Geodetic Survey into teaching, upon return to the author's Alma Mater; realization that problems are not the same, and how incentive is provided by having students contribute to construction of an actual map by tying courses in Higher Surveying and Photogrammetry together.

Educational Requirements of Property Surveyor

By S. A. BAUER
CIVIL ENGINEER, CLEVELAND, OHIO

The private practicing property surveyor should hold the same place in the surveying profession that the general practitioner holds in the medical profession. Accordingly, his education should be broad in scope and should include at least an appreciation of the functions of the various specialties, such as hydrography, photogrammetry, geodesy, etc., in order that he will be able to recognize his limitations and be able to recommend the proper specialist, or specialists, for the best performances of any particular job. Reciprocally, the specialists should also have some general knowledge of the functions and problems of the property surveyor, in order to integrate most completely the activities of the profession, and in order to provide the user with the best product.

Responsibilities of a University to Surveying and Mapping

By DR. N. PAUL HUDSON
DEAN, GRADUATE SCHOOL, OHIO STATE UNIVERSITY

Geodesy, photogrammetry, and cartography are progressing because of research and because the applications of new knowledge to a better understanding of the earth and its surface can be visualized. Further advances in these subjects depend on undergraduate and graduate education made possible by extensive and integrated educational resources, specialized facilities, and personnel skilled in teaching and research.

Ohio State University offers undergraduate and graduate work to the doctoral degree in physics, astronomy, mathematics, geology, civil engineering, geography, chemistry, electrical engineering, and supporting fields. The University enjoys an atmosphere of investigation and, inasmuch as it is all on one campus, is typified by a spirit of cooperation and easy relationships.

A group of faculty men from a number of departments, interested in geodesy, photogrammetry, and cartography, and encouraged by certain outside agencies, proposed that these subjects receive increased impetus in the University. After a study of its resources and the potentialities of the three fields, the University established, in the Graduate School, during the year, an Institute of Geodesy, Photogrammetry, and Cartography.

The functions of the Institute are to encourage the association of faculty members interested in the fields mentioned; to organize an undergraduate curriculum in

these subjects; to arrange interdepartmental programs for students at the graduate level; and to encourage and correlate research throughout the University in these three fields.

The administration of the Institute is in the hands of an Executive Board, composed of a Scientific Director, Executive Director, Dean of the Graduate School, Dean of the College of Arts and Sciences, and two faculty members.

With its resources and the assistance of interested agencies elsewhere, the University expects to be able to promote education and research in geodesy, photogrammetry, and cartography. In so doing, it will contribute to the fundamental and professional development of surveying and mapping.

Accounting Device Speeds Road Survey

NEW JERSEY State Highway Department engineers—taking advantage of the versatility of conventional punch-card accounting machines—have developed a new means of determining traffic flow through heavily traveled intersections.

According to Commissioner R. J. Abbott, the new system has resulted in savings of 90 percent over older traffic check methods. Results have been so good, in fact, that the U. S. Bureau of Public Roads is now urging other states to adopt the idea for accuracy and efficiency, Mr. Abbott said.

Punched cards—similar to those used in police identification systems and in accounting—are used as a basis for mechanical segregation of information gathered by the survey.

Here's how the system works: Motorists entering the traffic circle under study are handed a card upon which has been pre-punched the hour and point of entrance and type of vehicle. When they leave the intersection, they surrender the card to state highway employees stationed at each exit point. From the cards, then, several classifications of information are available:

1. How many of each type of vehicle passed through the circle at any given hour,

2. Where the vehicles entered the circle, and where they left it.

By keeping the cards gathered at each exit point in separate hourly groupings, it requires only a single operation in the highway department's home office in Trenton to punch added information on 80,000 or more cards. And here, according to Abbott, is where the saving comes in.

Previously, it took a group of experts several weeks to analyze the information gathered from field surveys of this type. But, by combining the card-punch system with the electrical accounting machine—which can separate the desired cards by the punched holes at an enormous speed—only hours are needed.

The system was used most recently in a survey of the intersection of State Routes 42 and 45 in Camden County, preparatory to modernizing this important highway junction. This particular survey was completed in 2 days.

Mr. Abbott pointed out that, normally, such a survey would result in long tally sheets turned in by each man used for checking. These would have to be assembled on master sheets and then evaluated by the experts, with allowances for errors both in obtaining the figures and in transcribing them.—*Engineering News-Record,* November 2, 1950.

Control Surveys for Chesapeake Bay Bridge

By C. L. YOUNG

SURVEY ENGINEER, J. E. GREINER COMPANY

CHESAPEAKE BAY BRIDGE spans Chesapeake Bay about 0.5 mile south of its narrowest part at Sandy Point; here it is about 4.3 miles from shoreline to shoreline.

The entire bridge is not built on one tangent—a 1-2/3° curve was introduced about 3,100 feet out from the west shore. The point of intersection of the tangents to the curve was in the ferry channel, about 4,800 feet from the western and 18,400 feet from the eastern shores. The surveys for a project of this size on land would probably present no unusual problems. Across water more than 4 miles wide, where chords are limited by the distances between piers or survey platforms and the sites of these platforms are restricted so as not to interfere with the operation of vessels in the ferry and ship channels, the survey planning becomes a little more complicated. No new methods of surveying were devised, but at times we may have applied simple surveying methods in unusual manners.

To determine the most suitable structure and location for a bay crossing, several sites were considered for both a bridge and a tunnel. The old lines used in the studies of 1938 were relocated and new lines for additional study were established by triangulation and traverse from Coast and Geodetic Survey triangulation stations and other fixed points along the shorelines. While searching for these old stations and points we recovered Δ KENT ISLAND NORTH BASE from information supplied by B. Everett Beavin, Associate Engineer with the J. E. Greiner Company of Baltimore.[1] This station had been reported lost for almost 100 years. From these surveys we also established control points on both shores to be used in locating borings, test piles, and soundings by sextant observations. After the location of the bridge had been definitely determined, the tangents were laid out and reference monuments were set on the shores from preliminary traverse surveys and were later checked and adjusted by triangulation. The triangulation net was expanded from these stations, as shown in the accompanying illustration. On the western shore Δ PUMP was set on the centerline of the bridge tangent west of the curve; Δ MOSS was set on the projected line of the tangent of the bridge east of the curve at about 3,700 feet south of Δ PUMP; and Δ S. R. C. "A" was a Coast and Geodetic Survey station on Sandy Point about 3,000 feet north of Δ PUMP. We would have preferred greater distances between these stations but the shoreline north of Δ S. R. C. "A" and south of Δ MOSS trends away from the bridge, and any station on the shoreline further north or south of these points would have been of little value to us in intersecting points along the centerline of the bridge.

On the eastern shore Δ 347 + 00.78 was set on the centerline of the bridge, and Δ HARR was set on the shoreline about 10,000 feet north of Δ 347 + 00.78. We had hoped to use Δ NOPRI as this corner of the quadrilateral, but

Presented at Eleventh Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 18–20, 1951.

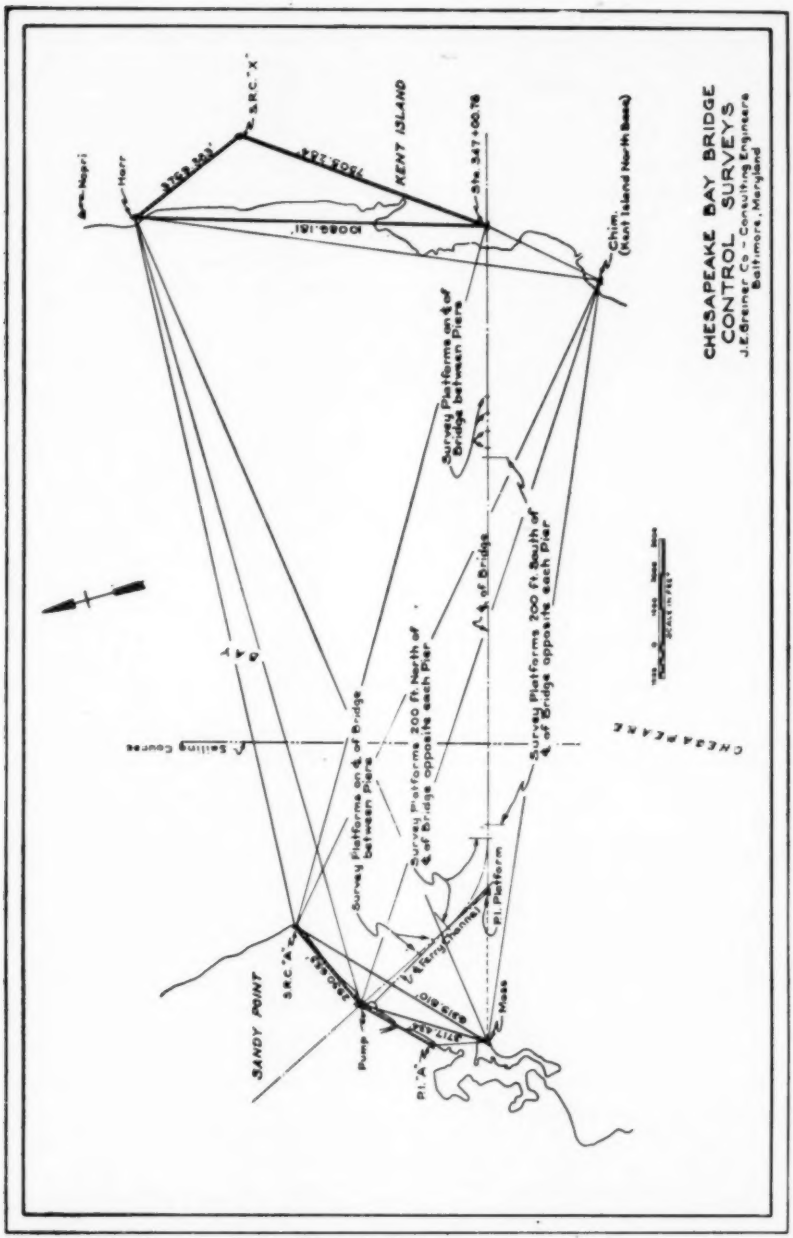
[1] See "Kent Island North Base, 1844–1947," by B. Everett Beavin, SURVEYING AND MAPPING, Vol. IX, p. 216.—EDITOR

the owner of the property denied us permission to erect and maintain an observation tower on this part of his land. A station north of his property would have been too far from the center of the bay at the centerline of the bridge for accurate intersection and, in addition, an observer would have been facing the sun, making a target very difficult to see. Station CHIM was set about 175 feet from Δ KENT ISLAND NORTH BASE on line with it and Δ S. R. C. 'A". A station on the shore south of Δ CHIM would not have been visible from either Δ 347 + 00.78 or Δ HARR. Stations CHIM and HARR were located by traverse from ΔKENT ISLAND NORTH BASE and Δ NOPRI, respectively. In selecting stations for our triangulation net, consideration was given to their accessibility, visibility, and distance from the centerline of the bridge, in preference to the strength of figure.

The nature of the terrain on both shores precluded long base lines adaptable to straight line measurement. On the western shore, the line from Δ S. R. C. "A" to Δ PUMP was staked and taped with an accuracy of 1 in 1,274,000, and a probable error of 1 in 1,349,000. From Δ PUMP to Δ P. I. "A", we had an error of 1 in 240,000, with a probable error of 1 in 703,000, measured over chaining bucks and stakes. The line from Δ P. I. "A" to Δ MOSS was across water too deep for direct measurement. We computed the distance from Δ PUMP to Δ MOSS from the measurement Δ PUMP to Δ P. I. "A". The length of the line S. R. C. "A" to MOSS was computed from these lines. On the eastern shore the distance from Δ 347 + 00.78 to Δ HARR was determined from taped measurements along the two lines through Δ S. R. C. "X" over chaining bucks and stakes. The southern line from Δ 347 + 00.78 to Δ S. R. C. "X" had an error of 1 in 2,085,000 and a probable error of 1 in 6,000,000. The northern section from Δ S. R. C. "X" to Δ HARR had an error of 1 in 202,600 and a probable error of 1 in 465,000. The error of the entire line was 1 in 800,500 with a probable error of 1 in 1,342,000. Two invar tapes, each 100 feet long, were used in making these measurements, with a third invar tape in reserve for use in checking. The tension handles were checked daily or before and after completing any line. All measurements were made on cloudy days in the daytime.

Observation towers were built at all stations in such a manner that the instrument could be shielded from the wind and sun. The angles were measured with a repeating theodolite reading to 10 seconds. Two settings of the vernier were made with 12 observations to each set. The horizon was closed at each station and the triangle closure errors averaged less than 3 seconds. After the side and angle equations in the quadrilateral HARR-347 + 00.78-MOSS-S: R. C. "A" were adjusted by least squares, the distance carried from the base line 347 + 00.78-HARR to the line MOSS-S. R. C. "A", as computed from the measured lines from Δ S. R. C. "A" to Δ P. I. "A", had an error of 1 in 332,000. An additional check on the measured line S. R. C. "A" to PUMP was made through the quadrilateral HARR-CHIM-PUMP-S. R. C. "A" and, although the distance angles were small, the error after the side and angle equations were adjusted by least squares was 1 in 106,800. A check on the computed line PUMP to MOSS, made through the quadrilateral HARR-CHIM-MOSS-S. R. C. "A" using the same method, had an error of 1 in 320,000.

We had further plans to check these distances and at the same time estab-


CHESAPEAKE BAY BRIDGE
CONTROL SURVEYS
J.E. Greiner Co - Consulting Engineers
Baltimore, Maryland
S.R.C. "X"
KENT ISLAND
Sta. 347+00.78
Chim.
(Kent Island North Base)
Survey Platforms on ℄ of Bridge between Piers
Survey Platforms 200 Ft. North of ℄ of Bridge opposite each Pier
Survey Platforms 200 Ft. South of ℄ of Bridge opposite each Pier
Sailing Course
BAY
CHESAPEAKE
SANDY POINT
S.R.C. "A"
Pump
Pl. "A"
Pl. Platform
Mass
OLD SITE
NEW SITE

lish the Point of Intersection of the tangents to the curve by incorporating the station at the P. I. in a quadrilateral with stations MOSS, PUMP, and S. R. C. "A"; but by the time the ferry channel was relocated and the platforms built we had the ends of the curve established and set the P. I. by wire and tape measurements from these points.

Test piles were driven, according to plan, 200 feet south of the tangent of the bridge east of the curve, 200 feet north of the centerline of the curve, and 200 feet north of the tangent west of the curve.

Four of these piles with their attendant clusters of bearing piles were left in place and incorporated into survey platforms, with the intention of using them as stepping stones to carry levels across the bay before construction started. However, these pile clusters were not stable enough for this purpose and all but one were abandoned. It was planned to build stable survey platforms opposite and 200 feet south of the piers east of the curve to Pier 40, and opposite and 200 feet north of the piers on the curve and the tangent west of the curve to Pier 11. From Pier 11 to Pier 1 and from Pier 40 to Pier 57 they were to be built on the centerline between the piers on approximate 500-foot centers. In addition, we built survey platforms 200 feet north of the centerline where the tangents intersected the curve and at the point of intersection of the tangents to the curve.

It was hoped that the several substructure contractors would build the survey platforms first and thus provide means to carry the vertical control across the bay and establish horizontal control on each platform. However, the contractors did not all start work at the same time, and to provide control for the various contracts we established priority for the platforms opposite Piers 11, 23, and 31. Stations on these platforms were tied in to the control stations on shore by triangulation. Observations were made with a direction theodolite reading to 1 second. Eight settings were made and the same accuracy of triangle closure was obtained as in the initial triangulation.

As additional survey platforms were completed, the distances between these control points were checked by direct measurement with very satisfactory results. These measurements were made with calibrated wires up to 1,600 feet in length. By base line measurements we laid out a "calibrating course" 1,600 feet long, with monuments at convenient points along the line, for use in calibrating these wires. It was found that very accurate measurements could be made with these wires, providing proper precautions were taken in handling them and in applying the tension. For this purpose we used a No. 17-gauge music wire with a diameter of 0.039 inch. A wire of this size has an elastic limit high enough so that sufficient tension could be applied to keep the bottom of the catenary of the wire above the water between the survey platforms on the longest spans measured. The wires must not be wound on reels of small diameter; this also applies to long narrow tapes. For accurate measurement we use a different wire for each length of line; that is, the wire used for a 600-foot measurement was not used for an 800-foot measurement, etc.; however, the same wire may be used on several measurements if it is calibrated before and after each measurement. Bicycle wheels are used as storage reels and good bearings in the wheels offer little friction when they are used as the lever in applying tension.

When preparing a wire for measure-

ment across survey platforms or piers we simulate similar conditions on the calibration line on shore. The wires are marked with scratches on lead markers near the ends. In calibrating a wire, sufficient tension is applied to eliminate visible vibration and sway in the wire, keeping well below its elastic limit. Temperatures are read on both ends of the wire and, if possible, in the middle. The apparatus is then transferred to the survey platforms or piers to be measured, where it is used in a manner similar to that in making the calibration; the points are marked after making proper corrections for differences in temperature or difference in elevation between the points. Then the wire and apparatus are again transferred to the calibration line and checked. Best results are obtained before sunup, after sundown, or on cloudy days.

Elevations for exact grade were demanded for the western end of the bridge before we had sufficient platforms built to carry levels across the bay. We therefore adopted the elevation of Coast and Geodetic Survey bench mark GATE as the datum for all work on the bridge. To provide elevations for use at the eastern end of the bridge, the levels had to be transferred across the more than 4 miles of water using only three more-or-less shaky survey platforms. By taking the mean of a series of rod readings made during the most favorable conditions of slack tide, with very little or no wind, we were able to check our elevations determined from the tide to within 0.2 foot. This was close enough for preliminary soundings and dredging operations. Later levels checked the tidal data by 0.025 foot.

After additional and more stable survey platforms had been completed, more accurate levels were run during periods of slack tide and little wind, using the same methods but with considerably shorter sights. Observations showed that the movement of the survey platforms was generally horizontal, rather than vertical, and during calm periods fairly consistent rod readings could be taken. As the steel pier forms rose above the water, they provided more suitable settings for the instruments. These, in conjunction with the more stable survey platforms, provided better facilities for running levels across the bay, with more nearly equal back- and fore-sights. Where the back- and fore-sights could not be nearly equalized, we used reciprocal levels.

Over the longer spans and across the sections where survey platforms were either poor or entirely lacking, we determined the difference in elevation by the "river crossing"[2] method of leveling. Good results with this method were obtained from the western shore to Pier 9, from Pier 25 to Pier 26, from Pier 27 to Pier 32, and from Pier 54 to the eastern shore, distances of 2,500, 1,600, 2,700, and 2,600 feet, respectively.

After the bents and piers had been completed from the western shore to Pier 24, and from the eastern shore to Pier 54, differential levels run from the shores to these two piers tied well within the limit adopted for second-order levels, thus checking the "river crossing" levels of 2,500 feet and 2,600 feet incorporated in the initial run.

[2] A method of simultaneous reciprocal leveling involving an instrument and rod on each side of the river; two targets on each rod, one above and one below the line of sight (bubble centered) from the distant instrument; micrometer readings on top and bottom targets and with bubble centered for each observation; twenty-five observations for each set with each instrument; and an interchange of observers and instruments between sets one and two and between sets three and four.

Most of the bench marks between Piers 24 and 54 have been "lost" during the winter by movement of the survey platforms on which they were located. These bench marks will be replaced under more favorable conditions as additional steel pier forms rise above the water and furnish stable settings. In view of the results obtained at each end of the bridge, we do not anticipate any serious error in the elevations obtained with the "river crossing" method of leveling between Piers 25 and 26, or between Piers 27 and 32.

▼ ▼ ▼

Aerial Stockpile Inventory Cuts Costs 25 Percent

THIS YEAR a new aerial method was utilized by the Philadelphia Electric Co. to take stock of its fuel on hand at 10 different locations. The new procedure of taking inventory from the air proved accurate within 3 to 5 percent, provided the inventory figures in a matter of days instead of weeks, and cut costs by 25 percent. The company's total coal stock is more than 500,000 tons, and some of the stockpiles contain 85,000 tons.

The company knew that aerial mapping had been used successfully for reservoir studies, transmission-line locating surveys, and for distribution maps. Why not to check coal stocks?

Accordingly, the utility asked Aero Service Corporation of Philadelphia to look at costs and time schedules. It was determined that a single pair of aerial photos would provide the coverage needed for each site and that the necessary photo flights could be executed in a few hours. Ground control required four elevation points and two horizontal points for each location. Compilation of the topographic maps with precise optical machines would require a week or 10 days after completion of photography and field control.

When the company gave the green light to the project, the photo flight was scheduled for the next clear day. On the day of the flight, the utility's personnel were notified to be on watch for the survey plane, so that the exact time the inventory photos were made could be recorded, an important factor in later computations. The plane flew over at an altitude of 1,200 feet.

Each 9- by 9-inch aerial view covered approximately 75 acres. The stockpiles were photographed by overlapping stereopairs, which enabled mapping compilers to trace the contours with the aid of a special stereoplotting machine. In this way, a three-dimensional view is obtained, and the contour at each height can be fully plotted.

After plotting is completed, the area for each contour is measured with a polar planimeter. With these data, the cubic volume for each "layer" or segment of the pile can be computed. The total volume is the sum of the layers. Since computation is made from peak to base in sequence, it is self-correcting, and the total possible error for each pile is within 3 to 5 percent. The aerial photos, contour maps, and results of the computations for each stockpile were delivered to the Philadelphia Electric Company. To establish the tonnage for each pile, the company determined the unit weight of the coal by sampling.

Costs for such work vary according to the size of the areas to be mapped, locations, airport facilities, scheduling, and other factors. But even when only a few stockpiles are mapped, some savings will be possible. In addition to the advantages of speed and accuracy, the aerial method of taking inventory releases many engineering man-hours for other essential work.

According to Aero Service engineers, aerial mapping could be used to tally ore stockpiles or to make an inventory of spoil banks, should reworking be planned. It has been used to tally the amounts removed from open-pit mines, and an air survey of a "stockpile" of logs is now in progress.—EDWARD F. SHEEHAN. From "Engineers' Notebook," *Civil Engineering*, March 1951.

Cartography in the Submerged Lands Oil Cases

By A. L. SHALOWITZ
UNITED STATES COAST AND GEODETIC SURVEY

THE DECISION OF JUNE 23, 1947

AS MANY OF YOU KNOW, the Supreme Court of the United States on June 23, 1947, handed down a far-reaching decision involving rights in the 3-mile marginal belt off the coast of California. (*United States* v. *California*, 332 U. S. 19.)

Briefly, the basis for the decision was a suit filed by the United States against the State of California in which it alleged that the State was granting leases in the 3-mile belt authorizing the holders to extract oil and other products therefrom, for which California was receiving large sums of money in rents and royalties.

The Federal Government contended that California was without authority to grant such leases because the United States was the rightful owner of, or had paramount rights in, such submerged lands.

California filed an answer contending, among other things, that title to the submerged lands within a 3-mile belt adjacent to the coast was acquired by the Thirteen Original States from the Crown of England, and that since California was admitted as a State on an "equal footing" with the original States, she became vested with title to all such lands.

The United States moved for judgment on the basis of the State's answer and the motion was set down for hearing. No documentary or oral evidence was introduced.

There is no need herein to go into the exhaustive legal arguments, pro and con, that were presented by brief and oral argument; nor is it necessary to consider here the Supreme Court's reasoning in arriving at its conclusion. By a vote of 6 to 2, the Court declared that the Federal Government, and not the State of California, has paramount rights in and full dominion and power over the lands, minerals, and other things underlying the Pacific Ocean for a distance of 3 nautical miles seaward of the ordinary low-water mark and outside of the inland waters of the State, including bays, ports, and harbors. (In *United States* v. *Texas*, 339 U. S. 707 (1950), the Supreme Court held that the paramount rights of the United States extend to the edge of the Continental Shelf as against the State.)[1]

The California decision settled beyond a doubt the basic legal issues involved—that is, rights and powers over the marginal belt—but at the same time the Court recognized that exact location of the boundary line might involve many complexities and difficulties and that, in order to determine with greater definiteness particular segments of the boundary, more detailed hearings might be required. This poses a number of cartographic problems—and the term cartographic is

Presented at Eleventh Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 18–20, 1951.

[1] The Continental Shelf is the zone around a continent extending from the low-water line to depths at which there is a marked increase of slope to greater depths. Conventionally, its edge has been taken at 100 fathoms (600 feet), but it may vary considerably on the different coasts.

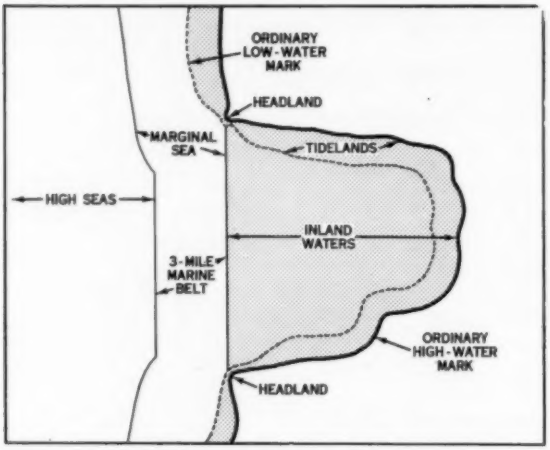


FIGURE 1.—Terminology used in delimitation of seaward boundaries.

used in its broad sense—that will have to be resolved before the closing chapter can be written to this case.

Before considering these, the scope of the decision, insofar as it alters or does not alter previously established legal rights, will be briefly discussed for purposes of background and clarification. Terminology is important in this respect.

TERMINOLOGY

In figure 1, the line marked "ordinary high-water mark" is the line where the tidal plane of mean high water intersects the shore. In riparian law, it usually marks the seaward limits of private property bordering the sea. And "ordinary low-water mark" is the line where the plane of mean low water intersects the shore. Seaward of the ordinary low-water mark is the marginal sea, also referred to as the "territorial sea," the "maritime belt," and the "marine belt." In the United States the width of the marginal sea is 3 nautical miles. This is the zone that was involved in the California litigation. Where the coast is indented by a "true" bay—a term which is explained further on—the marine belt extends 3 miles seaward of a line joining the outer headlands of the bay. Landward of the marginal sea are the inland waters. These are also variously referred to as "interior waters," "internal waters," and "national waters." Seaward of the marginal sea lie the high seas.

The zone between the high- and low-water marks is known as the "shore" or "beach." This is the land that is covered and uncovered by the daily ebb and flow of the tide and which the Supreme Court has on numerous occasions termed the "tidelands."

OWNERSHIP OF TIDELANDS

The California decision *does not* change the long established rule of law that the States and not the Federal Government own the tidelands, as well as the submerged lands under the inland navigable waters. This should be noted well, because of the current misunderstandings regarding the scope of the decision, particularly as it pertains to waterfront improvements that States and municipalities have made in ports, harbors, and other inland waters.

State sovereignty over such lands goes back to the early days of our Republic. Our State and Federal courts have repeatedly stated the theory on which such sovereignty rests. For centuries the title to the beds and shores of navigable waters within the territory or jurisdiction of England was owned by the Crown as an incident

of sovereignty, subject to the public rights of fishing and navigation. This was true of the English possessions in America.

After the American Revolution the Thirteen Original Colonies became sovereign States and, as successors to the Crown, became vested with the title to all lands within their boundaries over which the tide ebbed and flowed and to the beds of navigable waters.

With the adoption of the Federal Constitution, the States ceded to the Federal Government certain powers, one of which was the right to regulate interstate commerce, and with it the concomitant right to control navigation. No title to the tidelands nor to the lands submerged under navigable inland waters was thereby conferred and, as our Government is one of delegated, limited, and enumerated powers, any power not expressly granted or necessarily implied in the Constitution is beyond its scope. Title to the tidelands and to the soil under inland navigable waters therefore remained in the several States, to be disposed of by them as they deemed fit, or to be reserved for their own uses.

New States, such as California, entering the Union subsequent to the adoption of the Constitution were admitted "on an equal footing with the original States," and therefore acquired the same rights in the tidelands and submerged lands under inland navigable waters.

The Government's complaint in the California case did not challenge these decisions but, on the contrary, it stated that "this suit does not involve any bays, harbors, rivers or other inland waters of California, nor does it involve the tidelands." And the Court's decision expressly says "seaward of the ordinary low-water mark," which necessarily must exclude the tidelands.

CALIFORNIA CASE A NEW DECISION

Another misconception is that the Court, in deciding that the United States and not California possessed paramount rights in the 3-mile marginal belt, overlooked a long and unbroken record of contrary opinion. But, actually, the California case was the first to come before the Supreme Court in which the question of State-Federal ownership of the submerged lands of the marginal sea was put squarely in issue.

The large number of Supreme Court cases frequently cited as holding, directly or inferentially, that title to the submerged lands are in the States are not conclusive as to the lands of the marginal sea. In the language of the Court "none of these cases either involved or decided the State-Federal conflict presented here . . ." And the Court said: "Now that the question is here, we decide . . . that California is not the owner of the three-mile marginal belt along its coast, and that the Federal Government rather than the State has paramount rights in and power over that belt. . ."

The Court did not question the doctrine of States' ownership of submerged lands under their inland waters but, in the absence of precedent, it felt free to say whether the principles enunciated in such cases should be extended to areas outside the inland waters of a State—that is along the open coast. This it answered in the negative. In its judgment there were compelling reasons why the inland-water rule of ownership as an incident of State sovereignty should not be extended to the marginal belt.

If the Court had entertained doubts about the propriety of its decision in the California case it might have distinguished the Texas case, which is probably the strongest case for State ownership of the submerged marginal

lands, inasmuch as Texas at one time was an independent republic. But the Court said that when Texas came into the Union in 1845 she ceased to be an independent nation and came in on an equal footing with the other States and whatever claim she may have had to the marginal sea was relinquished to the Federal Government at that time. The Court failed to perceive any basis for departing from the principle it enunciated in the California decision. It has now spoken on three occasions (California, Texas, and Louisiana cases) and three times it has denied to these States rehearings on the issues. It can, therefore, be considered as settled law that the 3-mile marginal belt and, with greater force, the ocean beyond that limit to the edge of the Continental Shelf is in the domain of the Nation rather than the separate States.

The fact that certain aspects of the California case have been referred to a Master does not change the fundamental doctrine established by the Court. The reference is for the purpose of determining, with greater definiteness, specific segments of the boundary. These constitute the cartographic aspects of the case.

BOUNDARY AT BAYS

One of the important questions to be settled is where to fix the line separating inland waters from the marginal sea, particularly with reference to bays and estuaries. This will require a determination as to which bays are to be classed as part of the inland waters of the State and which are to be classed as part of the open sea. On the resolution of this problem will depend whether the boundary between Federal and State ownership at a bay will be a "headland-to-headland" line or whether it will be the ordinary low-water mark following the sinuosities of the bay. (*See* fig. 1.) No legal criteria have thus far been established that can serve as a precedent for such determination. International law affords some guiding principles.

Probably the most cogent available evidence on this question is the exhaustive study made by the North Atlantic Fisheries Tribunal in 1910 in the famous arbitration between Great Britain and the United States, relative to the rights of American nationals to fish to within 3 marine miles of British territory in Newfoundland. One of the points in dispute that the Tribunal had to decide was how the 3-mile zone was to be measured at indentations of the coast. The Tribunal decided that:

> In the case of bays, the three marine miles are to be measured from a straight line drawn across the body of water at the place where it ceases to have the configuration and characteristics of a bay. At all other places the three marine miles are to be measured following the sinuosities of the coast.

A little reflection will demonstrate the inadequacy of such criteria. The kind of an indentation that has the configuration of a bay and the kind that does not, was not settled by the Tribunal.

The coast of California is characterized by a number of indentations varying in amount of penetration into the coast and in distance between headlands. (*See* fig. 2.) Undoubtedly, an indentation such as San Francisco Bay would fall within the Supreme Court decision which excludes bays and other inland waters from Federal jurisdiction. But would this also apply to Drakes Bay, or Halfmoon Bay, or Monterey Bay, or Estero Bay? And, if not, then where is the dividing line? The mere fact that a body of water is called a "bay" does not make it so in a geometric sense, and should not be controlling.

The North Atlantic Tribunal made the additional recommendation that in

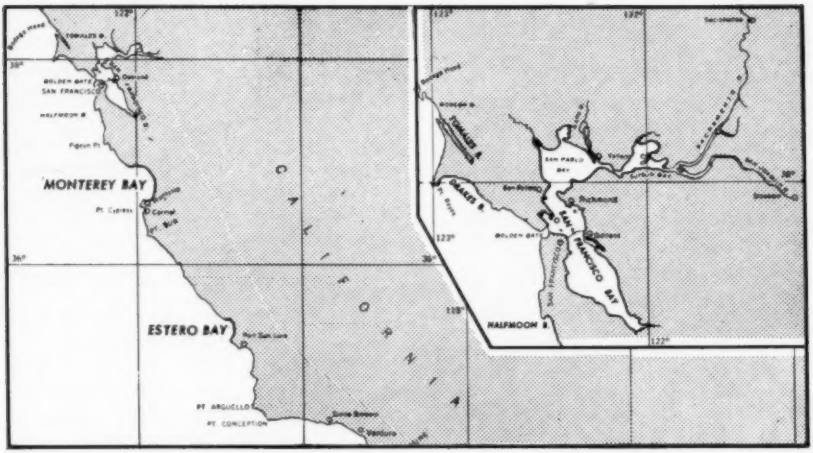


FIGURE 2.—Portion of California coast.

every bay not specifically provided for, the 3 marine miles shall be drawn "from a straight line across the bay in the part nearest the entrance at the first point where the width does not exceed ten miles." But this does not consider the extent of penetration of the indentation.

The Semicircular Rule

Whether a bay is a true bay in a geometric sense, or not, should depend, it would seem, on the extent to which the waters penetrate into the land or, more precisely, to the ratio of penetration to the dimension of the entrance. To express this ratio in geometric terms is the solution that is sought.

In 1930, the problem was studied by the Department of State and by the Coast and Geodetic Survey with a view to presenting a working formula to the Hague Conference for the Codification of International Law. The two agencies arrived independently at comparable geometric formulas for use in determining when an indentation of the coast is sufficient to be regarded as a *closed* bay, and therefore part of the inland waters of a country, and when it should be regarded as an *open* bay, and therefore outside of the inland waters.

For this purpose, a semicircular bay (fig. 3) having its diameter along the line joining the outer headlands is taken as the theoretical ideal bay which lies on the border line between an open bay and a closed bay. Then, if the area of the bay in nature, measured between the shoreline and a line joining the headlands, exceeds the area of the semicircle whose diameter is the line joining the headlands, the bay is a closed bay and the seaward boundary of inland waters is the headland-to-headland line. If the area is less than the area of the semicircle, the bay is an open bay and the boundary line of inland waters would be the ordinary low-water mark following the sinuosities of the bay.

In figure 3, curve *A* is a true semicircle whose diameter is the line *DE* joining the two headlands of the indentation. If the shoreline of the indentation, whose status is to be determined, is curve *B*, then it is readily

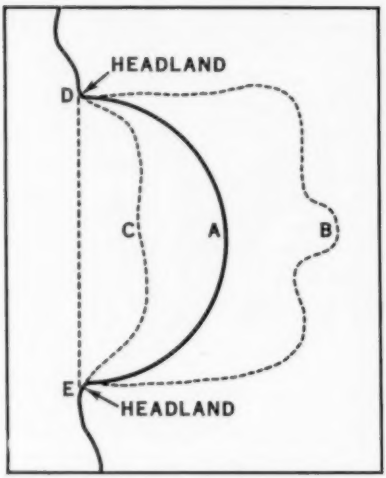


FIGURE 3.—The semicircular rule.

apparent that area *DBE* is greater than area *DAE*. The indentation is therefore a closed, or true, bay and would be part of the inland or national waters of a Nation. The seaward limit of inland waters or the begining of the marginal sea, would then be the headland-to-headland line *DE*.

On the other hand, if the shoreline of the indentation is curve *C*, then area *DCE* is less than area *DAE*, and the seaward limit of inland waters would follow the sinuosities of the indentation.

The practical application of this principle was worked out by S. W. Boggs, geographer of the Department of State, and is embodied in the American delegation's proposal to the Hague Conference.[2] The semicircle is found not by using the full distance between headlands as a diameter, but with a radius equal to one-fourth the distance. With this radius, arcs of circles are drawn from all points of the indentation. (*See* fig. 4.) Some of the arcs so drawn will be found to extend beyond the others. These constitute the envelope line, every point of which is a distance $\frac{1}{4}$ DE from the nearest point on shore. If the area, enclosed within the straight line and the envelope line, exceeds the area of the semicircle, as is the case in the upper diagram of figure 4, then the bay or estuary is to be considered as part of the inland or national waters. If the area is less than the semicircle, as in the lower diagram of the figure, then the indentation would be considered a part of the open sea and the seaward limit of inland waters would be the low-water mark following the sinuosities of the coast.[3]

This method of determining the status of an indentation has the advantage that it is applicable to estuaries as well as to bays, thus avoiding the troublesome problem of determining how far up a river to go in measuring the area. It also takes into account the characteristic shape of any indentation.

In some cases a smaller fractional part of the distance across the bay will be more desirable to use as a radius, for example one-fifth, in order not to generalize the shape of the bay too much. In such a case, the diameter of the semicircle would be three-fifths the distance across the bay.

In applying this method, the American delegation proposed a 10-mile limitation on the width of bays, follow-

[2] For a discussion of the American proposal, see Delimitation of the Territorial Sea, by S. W. Boggs, *American Journal of International Law*, Vol. 24, p. 541 (1930).

[3] The Hague Conference of 1930 adjourned without any definitive action being taken on the American proposal, but there was agreement on the method among the larger European countries, particularly Great Britain and Germany. (*See* "Delimitation of the Territorial Sea," *supra*, p. 550.)

ing the recommendation of the North Atlantic Fisheries Tribunal. In other words, in the case of bays wider than 10 miles at the outer headlands, a line is drawn across the mouth of the bay where it first narrows to 10 miles, and the formula then applied.

The Government is relying on this formula for the determination of *open* and *closed* bays.[4] Whether the Court will go along with this type of a yardstick remains to be seen, but this much can be said for it, it represents a scientific approach to the inland waters problem. Of course, even after a rule has been adopted, its application to the different configurations of a coast will still present the cartographer and the surveyor with many problems of interpretation.

Termini at Headlands

For example, there is the question of the ascertainment of the termini at the headlands of a true bay, or of a tributary waterway such as a river, that is a part of the inland waters of the State. Headlands are subject to almost limitless variation as to size, shape, and orientation. Therefore, any rule laid down must be general in character and may require exceptions in individual cases. In common usage, the word headland implies a land mass having a considerable elevation. However, for this purpose, elevation is not a pertinent attribute. We are concerned only with those relationships between land and

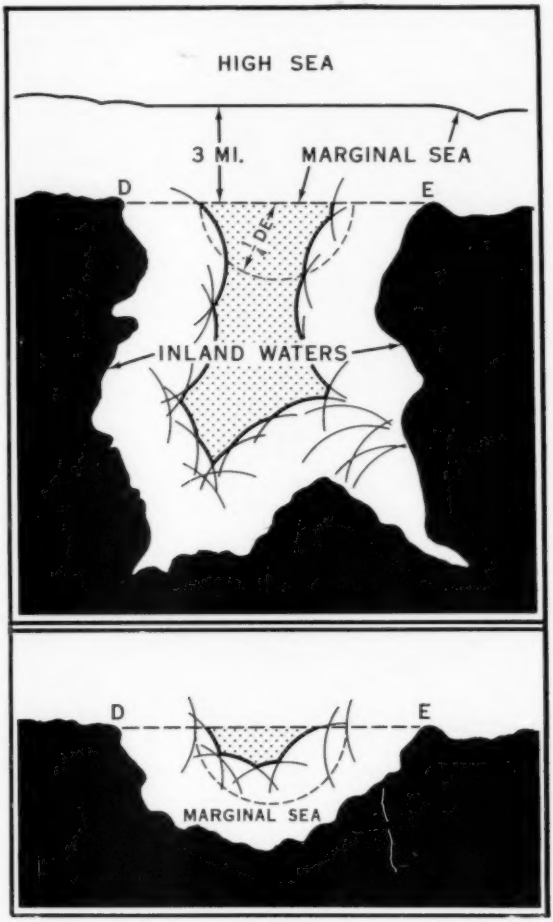


FIGURE 4.—Envelope method for determining status of an indentation. (After Boggs.)

[4] California takes the position that the status of an indentation should be determined on such considerations as history, physical and geographic factors, and use and occupancy of the area. (*See* pp. 5–8 of "Report of Special Master," *United States* v. *California*, filed in Supreme Court of United States, May 22, 1951.)

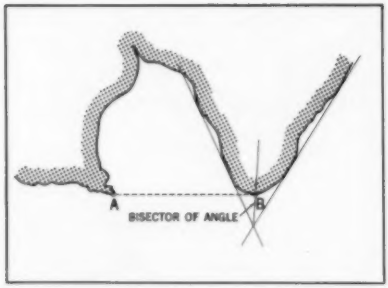


FIGURE 5.—The termini at headlands.

water which lie in a horizontal plane. We can, therefore, for this purpose define a headland generally as the apex of a salient of the coast; the point of maximum extension of a portion of the land into the water; or a point on the shore at which there is an appreciable change in direction of the general trend of the coast.

The shores of these headlands are formed by two different groups of forces—those of the ocean and those of the estuary or tributary waterway. The points sought are where the shores resulting from these different forces meet. Therefore, each terminus of the headland-to-headland line is taken as a point at the outermost extension of the headland from which it is drawn. There is frequently some one characteristic point, some minor shore form, as a spit, which obviously is the point sought. (*See* point *A* in fig. 5.)

Where the headland is of considerable extent with a gently rounded and featureless shore, a satisfactory solution may be reached by bisecting the angle formed by a line coinciding with the general trend of the low-water mark along the open coast, and a line coinciding with the general trend of the low-water mark along the bay or tribu-

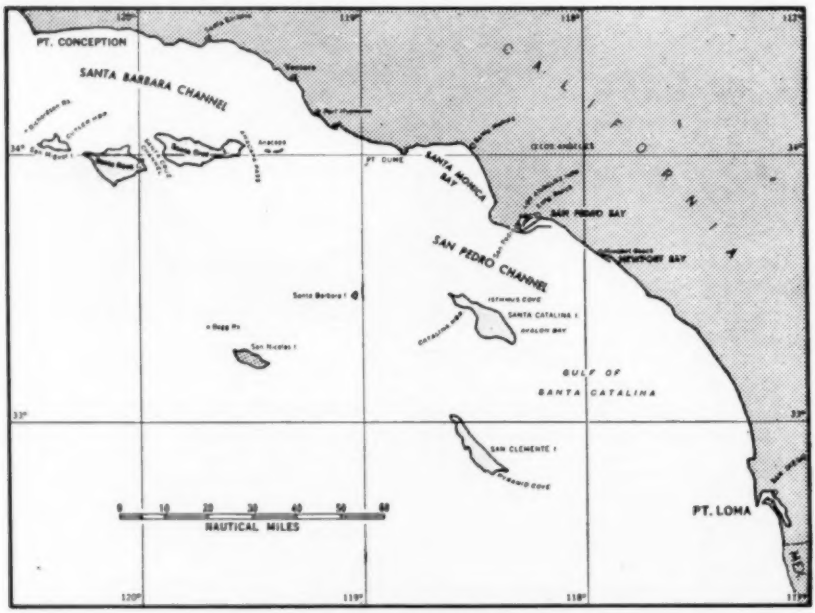


FIGURE 6.—Islands off the California coast.

tary waterway. Where this bisectrix intersects the low-water mark will be the point sought. (*See* point *B* in fig. 5.)

STATUS OF THE CHANNEL AREAS

An aspect of the California decision that will require some cartographic expression is the determination of the status of the channel areas between the California mainland and the islands offshore. (*See* fig. 6.) These islands are separated from the mainland by about 10 to 60 nautical miles, with depths in between as great as 6,000 feet. It is California's position that the channel areas constitute inland waters and therefore the Federal-State boundary should follow a line from Pt. Conception along the outermost rocks on the ocean side of all the channel islands, thence to Point Loma. (More restrictive alternate lines are also proposed.)

The Government contends that, because of the distances separating the islands from the mainland, the areas in between cannot be considered a part of the inland waters of California, but must be considered a part of the open sea, and therefore the Federal-State boundary should be along the low-water mark on the mainland and around each individual island. By applying the rules proposed by the American delegation for the delimitation of the marginal sea around islands and in straits, all the channel areas outside of the 3-mile marginal belt would become, for purposes of international law, a part of the high seas. If a more liberal view of the marginal sea is adopted for such areas in the interest of national security, then the entire area could become a part of the marginal sea, but hardly part of the inland waters of the State, except by arbitrary adoption.[5]

[5] *See* "Report of Special Master," *supra*, pp. 3–5; 36–41.

DEMARCATION OF THE ORDINARY LOW-WATER MARK

Another cartographic aspect of the submerged lands cases is the actual demarcation on the ground of the "ordinary low-water mark," as used in the Court's decision. Before this can be done, certain criteria must first be established.

In the demarcation of any boundary consisting of a water mark along the shore of the sea, two engineering aspects are involved—a vertical aspect, predicated on the height reached by the tide during its vertical rise and fall, and constituting a tidal plane; and a horizontal aspect, related to the line where the tidal plane intersects the shore to form the water mark desired. The first is derived from tidal observations alone and once derived, on the basis of long-period observations, is for all practical purposes a permanent one. The second is dependent on the first, but is also affected by the natural processes of erosion and accretion and the artificial changes made by man.

A water boundary, determined by tidal definition, is thus not a fixed visible mark on the ground, such as a roadway or fence, but represents a condition at the water's edge during a particular instant of the tidal cycle.

Tidal Datum Planes

And this brings up the matter of the different tidal datum planes in use. The rhythmic response of the sea to the attractive forces of moon and sun, called the tide, is not the same everywhere. It differs both in amount and nature of the rise and fall. This is graphically illustrated in figure 7, which shows the tide for 1 week in June at three places along the different coasts of the United States. For our purpose the important thing to consider at this time is the *nature* of the rise and fall rather than the amount.

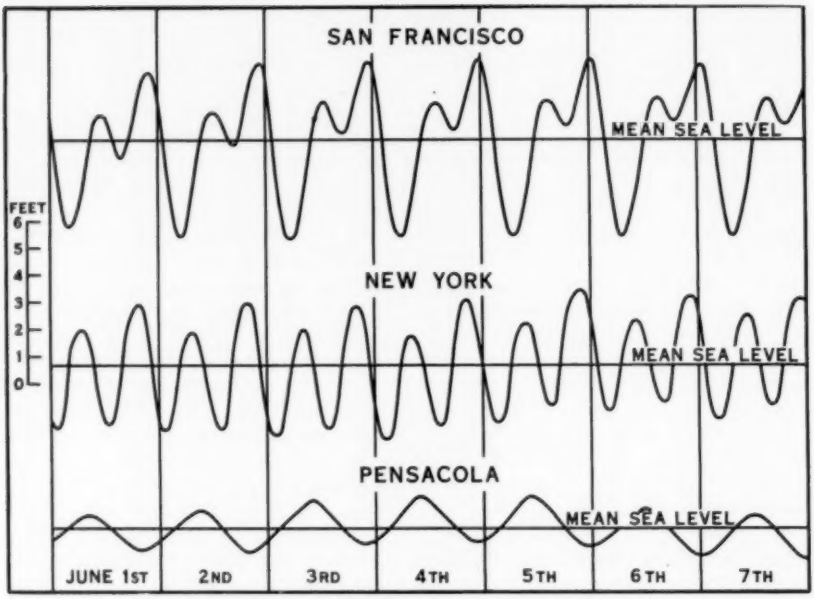


FIGURE 7.—Types of tide along coasts of United States.

It will be observed that at Pensacola only one high and one low water occur during a day, whereas at New York and San Francisco there are two high waters and two low waters each day. A closer inspection of the New York and San Francisco tide curves also shows that at New York there is relatively little difference between successive high waters or successive low waters, but at San Francisco the differences are quite pronounced, the greater difference occurring between successive low waters.

In selecting a tidal datum, or reference plane, cognizance must therefore be taken of the character of the tide in an area, as well as the specialized purpose which the datum is to serve.

In the survey and chart work of the Coast and Geodetic Survey three tidal datum planes are used. For referencing elevations, in the network of precise levels, the datum of Mean Sea Level is used, it being the most practicable datum for general engineering purposes. On the other hand, the dividing line between land and sea is best represented by a high-water datum and, therefore, for this purpose the datum of Mean High Water is used.

But as a datum for referencing water depths, or soundings, on nautical charts, neither a sea-level nor a high-water datum is satisfactory. For the navigator, the critical part of the tidal cycle is at the time of low water when depths are at a minimum. The controlling depth in a channel or over a shoal at this stage of the tide becomes important to the navigator, particularly where the controlling depth is not much greater than the draft of his vessel. A low-water datum is therefore used. Any datum higher than low water would result in greater charted depths and might lead the navigator into a false sense of security.

For nautical charts of the United States, low-water datums are of two kinds and are related directly to the type of tide existing along a specific coast. For tides of the types shown for New York and Pensacola, the most practicable datum is Mean Low Water, which is derived by averaging all the low waters over a considerable period of time. For the type that occurs at San Francisco, where successive low waters differ considerably, a datum based on the mean of the lower of the two low waters occurring each day is more serviceable to the navigator. If all the low waters were to be used, it would result in raising the reference plane in relation to the sea bottom, with a consequent increase in the charted depths. This would be subject to the same objection mentioned for sea-level or high-water datums. Therefore, on nautical charts of the Pacific coast, the datum of Mean Lower Low Water is used.

But the important point to keep in mind, insofar as chart datums are concerned, is that the topography of the sea bottom remains the same whatever datum is used, and it cannot be said that the use of one datum instead of another results in greater accuracy. The selection is dictated solely by the practical needs of navigation.

The term mean low-water datum becomes, therefore, one of technical definition and is not necessarily related to the chart datum. It is the same on the Atlantic coast as on the Pacific coast and is derived by averaging all the low waters over a considerable period of time, a 19-year average giving the best determination.

In the Court's decision the term "ordinary low-water mark" is used to define the Federal-State boundary. This term is not one which the Coast and Geodetic Survey has defined and standardized for survey operations and for technical engineering usage. But where used it is regarded as the equivalent of the term "mean low-water mark," which is the intersection of the plane, or datum, of mean low water with the shore. On the California coast this plane is derived by averaging *all* the low waters—the higher lows and the lower lows.

Once criteria have been adopted by the Court for specifically defining the boundary, it can be established along any segment of the coast by a simultaneous spirit level and planetable or traverse survey—tied in vertically to established tidal bench marks and horizontally to triangulation stations along the coast—or by some other method, possibly photogrammetric, or by a combination of methods.

PENDING LEGISLATION

The problems considered thus far are those growing directly out of the Supreme Court decision. They involve the common boundary between Federal and State jurisdiction at the inshore limit of the marginal sea. The offshore limit is not in dispute, because no common boundary is involved. Pending legislation may, however, require a cartographic delineation of the offshore limits of the 3-mile marginal belt. Such a line has never been defined with the precision which is necessary before it can be laid down on a chart. Various proposals have been made by geographers and cartographers. These usually fall into three categories: (*See* fig. 8.)

(1) *A Replica Line.*—This is the line which would result from lifting the low-water line bodily from its existing position, moving it 3 miles seaward and laying it down parallel to its former position. Such line would be an extremely irregular one.

(2) *A Conventional Line.*—This may be any one of an infinite number of possible lines.

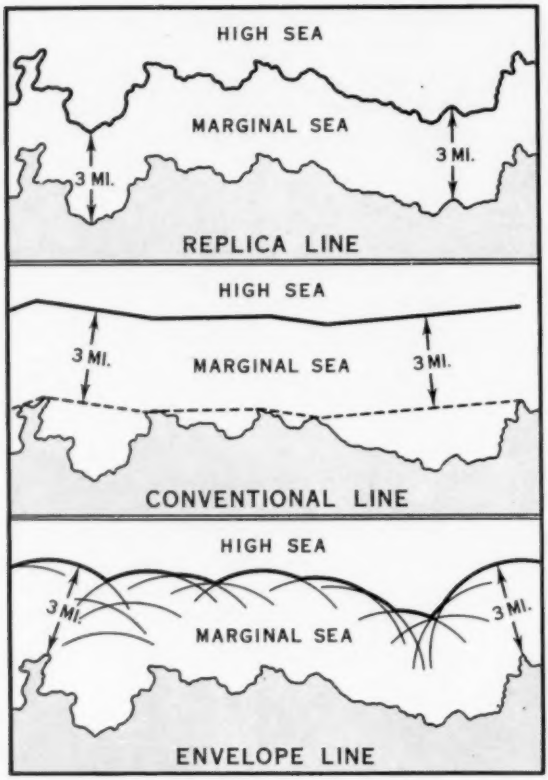


FIGURE 8.—Boundary at the marginal sea.

(3) *An Envelope Line.*—This is a line every point of which is exactly 3 miles distant from the nearest point of the low-water line. It is a much simpler and less irregular line than the replica line and yet, unlike the conventional line, it adheres literally to the 3-mile requirements. It is the line that the American delegation to the Hague Conference of 1930 proposed for delimiting the boundary between the marginal sea and the high sea and is the envelope of the arcs of circles of 3-mile radius drawn from all points on the low-water line and from the exterior limit of inland waters.[6]

[6] *See* "Delimitation of the Territorial Sea," *supra*, p. 544.

The envelope line affords a reasonable method of delimiting the marginal sea. It is applicable to a 3-mile belt as well as to any other distance from the coast. And even for the most complex coast it constitutes a relatively simple line, easy to construct.

SUMMARY

To summarize then, the Supreme Court decision of June 23, 1947, established the doctrine that the United States, and not California, possesses paramount rights in, power, and full dominion over the resources, including oil, of the submerged lands lying seaward of the ordinary low-water mark for a distance of 3 nautical miles from the coast and outside of ports, bays, harbors, and other inland waters. (In the Texas case the Court held that paramount rights of the Federal Government extend to the edge of the Continental Shelf.)

The decision did not change the long-established rule of law that the States, and not the Federal Government, own the tidelands (land that is covered and uncovered by the ebb and flow of the tide, and commonly known as the shore), as well as the submerged lands under inland navigable waters.

The California case is not a departure from previous Supreme Court pronouncements, but represents the first High Court decision in which the State-Federal question of ownership of the

submerged lands outside of inland waters was put squarely in issue.

The decision poses a number of cartographic problems which will have to be resolved before the case can be satisfactorily terminated. Chief among these are: establishing criteria for ascertaining the exterior limits of inland waters,[7] determining the status of the channel areas between the California mainland and the islands offshore, and laying down principles for the actual demarcation of the ordinary low-water mark on the ground.

[7] California has consistently maintained throughout the proceedings before the Master that the determination of the exterior limits of inland waters automatically fixes the national external boundaries of the United States and is therefore a political question, to be settled by the legislative and executive branches of the Government rather than by the judicial branch.

* * *

Barrier Island, Not "Offshore Bar"

DOUGLAS W. JOHNSON in his shoreline treatise concluded that the sandy barrier bar or island of gently sloping shoreline bottoms, such as those of coastal plains, originated largely as a bar or bars formed offshore—normally submerged—and that the driving into shallow water of a series of such bars and their up-building there led to the emergence above normal tidal range of a barrier island. Hence, he called the island an "offshore bar," a term which has been accepted by many geologists.

Textbooks of geomorphology and geology have not, so far, arrived at a full standardization of coastal terminology. Thus, F. P. Shepard's *Submarine Geology* speaks on one page of the barrier island as an "offshore bar," but on another uses the same term for any one of a series of normally submerged bars found at increasing depths on and seaward from a gently sloping beach. Ph. H. Kuenen's *Marine Geology* seems to use "offshore bar" only in the Johnsonian sense, but repeats Shepard's figure in which a bar is shown in the offshore zone of the beach without providing a specific qualifying term for such a bar. Kuenen's contribution to the confusion in the use of "offshore bar" is to term some of them "sandbanks," thus attempting to appropriate for a specific technical meaning a term long in wide common use for any kind of sandy beach, dike, or levee.

The following terminology is proposed to correct the ambiguity and double uses noted:

1. *Offshore bar.*—Any normally submerged bar formed offshore in marine or fresh waters, found chiefly in the littoral zone. It includes, among other bars, the ridges of the low and ball topography that have been called "sandbanks" by Kuenen and "long-shore bars" by Shepard, the latter being here preferred.

2. *Barrier island.*—The island, or chain of islands, of sand, sand and gravel, or shingle, lying offshore on a gently sloping shallow bottom. It is separated from the shore by a coastal lagoon or "sound." Its beach is the main line of resistance of the land to the attack of the major waves of the offshore region, the beach slope forming a profile of equilibrium. The term is used technically and includes, as a single barrier island or *barrier island chain,* such segments in the same alignment as may be separated by tidal inlets or other tidal openings. This barrier is commonly tied to land at one or both ends, either to a stream delta or to a headland of some other origin, as an erosional projection of a drowned coast.

3. *Barrier reef.*—An organic, commonly partly coralline, reef lying offshore from a continent or island, much in the position of the barrier island of sand. It includes barrier reefs of islands—commonly volcanic—and such great barrier reefs as that of the northeastern Australian coast. The terminology of coralline reefs is fairly well stabilized.—Extract from note by W. Armstrong Price, *Science,* April 27, 1951.

Shoran for the Photogrammetrist

By ARCHER M. WILSON

CHIEF, SHORAN SECTION, ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES

THE most direct application of Shoran to the compilation of photogrammetric maps is its use in controlling aerial photography. The technique employed is somewhat analogous to the well-known transit-intersection method, except that a distance-measuring rather than an angle-measuring instrument is used. Positions are established by electronically measuring the distance from a photographic aircraft to each of two ground stations at the instant of exposure of the aerial camera.

These "airline" distances must first be reduced to their corresponding ground lengths before the triangle can be solved to obtain horizontal position of the airplane. It is necessary, of course, to know the distance of the "base line" between the ground stations. Normally, this is accomplished by selecting ground sites near existing triangulation stations and making the necessary ties by a short transit-and-tape traverse.

It is this photogrammetric application of Shoran that has received attention at the Engineer Research and Development Laboratories under a project with which the writer has been connected. The general plan of research and over-all objectives of the investigation were supplied by the Chief of Engineers, and were designed to provide results that could be utilized in fulfilling requirements of the U. S. Army mapping plan.

The first and, in fact, the only test photography available to date has been coverage that was flown in 1946 with Shoran equipment modified very little from the original bombing model. The accuracy attained on the tests was given in a paper presented by Mr. Lorenz at the 1946 Semi-annual Meeting of the Society in Dayton. To review these results briefly, it was found that the positions contained both a constant and a random error.

The constant error, which results in a shift of the finished map sheet with respect to the ground stations, was found to be less than 40 feet with careful calibration of the equipment. In addition, the individual positions were found to contain random errors of about $\pm$ 125 feet or less on 90 percent of the points. However, when multiplex methods were used to "average out" these individual errors, it was possible to compile maps with random errors of no more than 105 feet on 90 percent of the well-defined features, even with 20,000-foot photography. It should be remembered that these results were obtained with Shoran in 1946. There is little doubt that present-day equipment will produce much better accuracy. Recent modifications to both the airborne and ground instruments make this almost certain.

The much-discussed Shoran line-crossing method, which is used to build up a triangulation network, is not a part of the ERDL investigation, though the work accomplished to date has been followed closely. Of major interest to the photogrammetrist is the fact that points established by this method can then become controlling ground stations for Shoran photography. Furthermore, it has often been found that new computing methods or other tech-

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niques designed for Shoran triangulation can be applied directly, or with some slight modifications, to aerial photographic control. A third reason for following the line-crossing work is that it reveals the continuous improvement in the equipment, and thus provides a yardstick for use in predicting the accuracy to be expected from Shoran-controlled photography.

STUDIES AT ERDL

After the accuracy tests had been completed at ERDL, and Shoran proved to be suitable for use, at least in some areas, our studies were directed toward the more practical objectives of developing procedures and auxiliary mapping instruments for adoption by Army operational units. Techniques were designed to vary from existing standard Army methods as little as possible, in order to minimize changes in tables of organization and equipment. Only time and experience will reveal the universality with which this type of electronic control can be employed, and the amount of specialized equipment that will be warranted.

TYPICAL SHORAN MAPPING PROBLEM

Perhaps the easiest way to summarize the development work, and to outline Shoran photogrammetric mapping as visualized by the Corps of Engineers, will be to select an imaginary area and briefly run through the various steps required in planning, computations, and compilation. Let us assume that we want 1:50,000-scale maps of four 30-minute quadrangles in a remote area. Photography is to be taken at 20,000 feet above mean ground elevation, for compilation by multiplex methods. The only existing horizontal control consists of an arc of triangulation running parallel to one edge of the area and about 50 miles away. Vertical control is limited to a few known elevations along a railroad which runs diagonally across the total area. An effort is to be made to delineate contours at intervals of 100 feet, though it is realized that they probably will not meet normal map accuracy requirements.

OFFICE PLANNING

Preliminary office planning by the photogrammetrist is done on the best available small scale of the area, usually a Strategic Map or Aeronautical Chart (fig. 1). The area to be

FIGURE 1.—Map study.

covered is outlined, and all geodetic positions along the line of existing triangulation within about 200 miles are spotted for consideration as possible ground-station sites. Our sample map covers only about 20 percent of the area that can be controlled from a single pair of ground stations, so we can limit our office study to selection of the one or two most likely pairs. A field verification of all likely sites will be required before final acceptance. Of first importance are the requirements that the aircraft always be within Shoran radio range, and that the "angle of cut" (that's the angle at the aircraft) from both ground stations is such as to give a strong geometric solution. With present equipment, this angle should be kept between

the limits of 60 and 120 degrees. Both conditions can be verified with sufficient accuracy on a slide rule, from approximate distances scaled from the map.

The map study also will indicate, to some extent, the accessibility of the sites and the possibility of obtaining living accommodations and telephone service for the ground crews. Since installation of the ground equipment normally is an airborne operation, sites should be kept as near as possible to airfields. Still another consideration is to select points which will facilitate use of the airborne straight-line indicator. This very important adjunct to the system has proved to be a valuable aid in supplying the mapper with regularly spaced, straight flight lines, devoid of gaps or excessive side laps. It operates best, however, when the Shoran base line roughly parallels the flight lines. It can be seen that careful office planning will pay good dividends during nearly all later operations.

Photographic specifications prepared by the mapping organization will be very similar to the usual type, but will incorporate provisions for specifying the needed Shoran data. A complete discussion of the calibration requirements, and many other details needed in the specifications, is beyond the scope of this paper, and is of interest only to those who are intimately connected with this phase of the work. Mention should be made, however, of a special flight plan that will be utilized as an aid in recovering camera orientation during later multiplex operations (fig. 2). In addition to the normal type of coverage with parallel flights, we will require right-angle flights across the area, spaced at intervals of about each six exposures. This cross-flight photography is not required in areas where there is sufficient vertical control to level the regular photography, but will be needed in our hypothetical example.

AIRBORNE OPERATIONS

With the submission of the specifications, the responsibility for successful

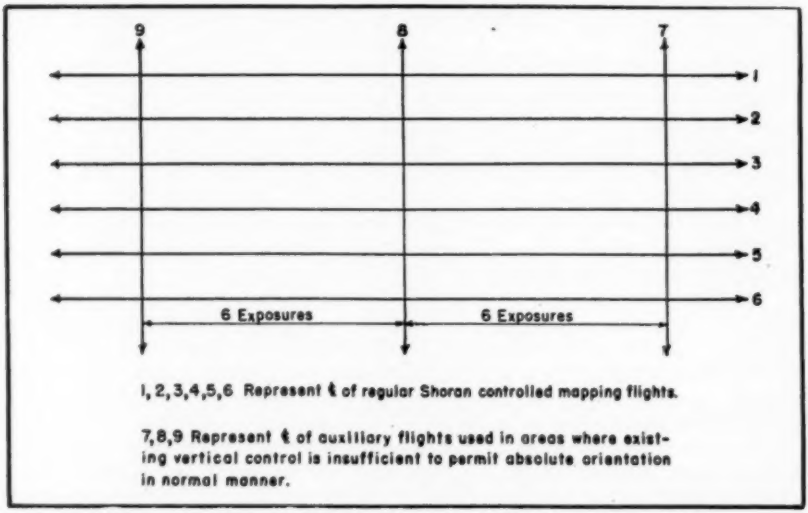


FIGURE 2.—Special flight plan for areas of limited vertical control.

execution of the photography rests with the aerial photographic unit. However, because of the newness of this type of control, it is believed that a liaison representative from the mapping organization should closely follow all later steps, commencing with the ground station reconnaissance (fig. 3) and carrying through until delivery of the photography. His duties will be

FIGURE 3.—Shoran field reconnaissance.

varied, and will include such things as approval of the photography, authorizing changes in the flight plan, and giving assistance in assembling the necessary electronic and meteorological data. He also must be sure that exposures from all the airborne cameras have been properly correlated. Each photographic airplane, in addition to the aerial camera, carries a Shoran data recorder and an altimeter recorder. Since the exposure counters in these recorders are subject to mechanical failure, it is necessary to be constantly alert to possible errors from this source. In emergencies, recourse must be made to a comparison of the times registered on navigation watches that appear in all exposures.

The execution of the airborne and ground operations involved in a successful Shoran mission is a story within itself and cannot be covered here. Nevertheless, it should be mentioned that, though exacting, procedures have been developed by the U. S. Air Force, and in particular the Second Air Force, that will practically guarantee acceptable results regardless of the area in which the equipment is put to work.

SHORAN COMPUTATIONS

As far as the photo-mapper is concerned, the next phase commences with receipt of the aerial photography and accompanying Shoran data. The preliminary work, as with any job, consists of examining the film, indexing and filing, and the preparation of photo indexes. We can also start preparing diapositives, since multiplex compilation methods are to be employed. In the meantime, the computing team starts extracting all recorded information that will be needed in transforming from basic Shoran readings to usable map coordinates. Special computation forms have been designed for the entire operation so as to permit utilization of personnel with a minimum of training.

The first step will be to compute the correction needed to reduce each of the Shoran distances to its corresponding ground length. Since we probably have somewhat over 400 pictures, with each picture representing two measurements, this would be quite a job if each line were computed separately. Instead, the reductions from each of the ground stations are computed only for the even 5-mile intervals throughout the range of the mission, assuming that the aircraft flying height remained constant. These values can then be used to prepare a curve from which corrections for the individual readings are taken. It also is necessary to apply

a small differential correction for any exposure that deviates from the assumed constant flying height by more than about 100 feet. After adding in any instrument errors that were determined during calibration, we obtain the ground distance to each base station for each exposure.

The solution of the resulting triangles and subsequent point plotting are accomplished through a special grid based on a doubly equidistant projection, tailored to the Shoran problem. The projection has the property that distances from any point within the map to either ground station are "true." Distances between other points are in error, but within the area covered by a single map sheet, they are inconsequential. The Shoran grid has its X-axis through the two ground stations, and uses the westernmost station as the origin of coordinates. As the projection creates a simple plane triangle, coordinates of each exposure can be computed at a rate of less than 2 minutes per point. This is only a fraction of the time that would be required to solve a spherical triangle for geographic coordinates.

MULTIPLEX OPERATIONS

Scaling of the multiplex models to the Shoran positions requires a few special procedures. It was previously noted that the Shoran points contain random errors of as much as 150 feet or more, and it is just as likely as not that two adjacent points might be in error in almost opposite directions. Thus, a relative error of as much as 300 feet could be introduced between a single pair of projectors. It becomes necessary, then, to scale a number of models as a unit to the best average fit of the control. Tests show that the best accuracy is obtained when strip units of about six models are used.

Another very important consideration in the multiplex scaling is to recover the camera orientation properly. A Shoran position represents the point directly beneath the aircraft. The corresponding position on the photograph is the nadir point, and any error in its proper recovery will be reflected as a horizontal error in the map. In our hypothetical photography from 20,000 feet, an error of 1° in tilt recovery would introduce a horizontal error of 350 feet. A tilt error of only 17′ would cause a displacement of 100 feet. Unless we have a fairly reliable method for getting the models level, then, tilt errors may have a worse effect on map accuracy than does the Shoran error. It was this consideration for recovering camera orientation that governed our request for the addition of cross flights to the otherwise normal flight plan. Through their use, a multiplex procedure has been evolved which has been quite successful in establishing photo tilts. The method also provides for the addition to our map of contours, or at least form lines, since any level model plus the addition of a datum elevation is all that is needed.

RELATIVE ELEVATIONS FROM CROSS FLIGHTS

Multiplex work is started by setting the cross flights first, and these are oriented in units of about six models. Great care must be exercised in establishing proper relative orientation. The terrain will often contain rivers, lakes, or other features which can be relied upon for the first rough-leveling of the strip. Scale accuracy, sufficient for the cross flights, is obtained by holding the principal point of each end-projector to its corresponding Shoran position. Finally, the strip is carefully leveled in line of flight by assuming that difference in flying height as indicated on the altimeter is correct. In other words, if the altimeter shows

the same reading for the exposure at both ends, the handwheels are adjusted until the end-projectors are at the same height above the plotting table. Where the altimeter shows a difference in flying height, the end-projectors are adjusted accordingly. In this orientation, we accept the strip leveling as being correct along the line of flight. Individual models, however, are still in error as a result of the fall-off, or "*BZ* curve" effect, that is characteristic of most stereoscopic extensions.

FIGURE 4.—Measuring multiplex projector heights.

FIGURE 5.—Preparing multiplex *BZ* curve.

A *BZ* curve for the orientation is prepared by plotting the projector heights against distances along the center line of the models (figs. 4 and 5). Elevations read at frequent intervals along the flight line then are corrected by an amount equal to the corresponding ordinate of the curve. Where the particular strip at hand includes one of the known elevation points along the railroad, all other elevations can be reduced to a sea level datum. Otherwise, the pass-points provide relative heights only.

MULTIPLEX SCALING

The orientation of all the cross flights in a similar manner provides us with lines of relative elevations across the area, spaced at intervals of about each six models. The regular parallel flight coverage is then oriented in the multiplex, selecting strip units that permit bridging between our previously established lines of relative heights. Units now can be leveled in the flight direction by reference to the altimeter readings, and across the line of flight using the elevation differences of our pass-points. Nadir points can be selected with confidence, and the entire unit scaled to the best mean fit of the Shoran positions. It should be noted that the true nadir point of the photo is not identical with the nadir point of the multiplex projector. Because of the fall-off effect in our strip extension, each projector contains a small amount of "false tip" which is equal to the slope of the *BZ* curve at the point where it passes through the projector in question. The necessary correction to the indicated nadir is obtained by multiplying the projector height by the tangent of the angle (fig. 6). When the unit has been completely oriented,

enough pass-points are selected so that it can be reset and the map detail drawn in.

Vertical pass-points in each model are selected at the same time as horizontal points, corrections for the *BZ* curve effect being taken into account as with the cross flights. A sea-level datum is picked up each time the models contain known elevations and is carried back along the regular flights and cross flights until it reaches every model. Any written discussion of the *BZ* curve method appears rather involved, but actually the procedure is quite simple to apply in practice. Many of you undoubtedly applied the method to a great extent during the last war when map control was almost as much a luxury as fresh milk.

DETAIL COMPILATION

Multiplex compilation of the Shoran controlled map is no different from that of any other type. In some cases, the models will be drawn individually using sheets onto which the pass-points have been traced. In other cases, the sheets used during the scaling operation will be supplied. Standard procedures also apply in all later steps of drafting and reproduction.

CONCLUSION

This discussion has attempted to outline Shoran photogrammetric mapping as envisioned at the Engineer Research and Development Laboratories. All procedures are tentative at this time since both the equipment and the mapping methods are still considered to be under development. Furthermore, as with any new tool, the techniques of application may need to undergo considerable revision, when they are integrated into the routine of an operating unit. This does not mean that we still have a long way to go. Shoran is in actual productive mapping use at the present time. Further development will only enhance its value to the geodesist and the photogrammetrist.

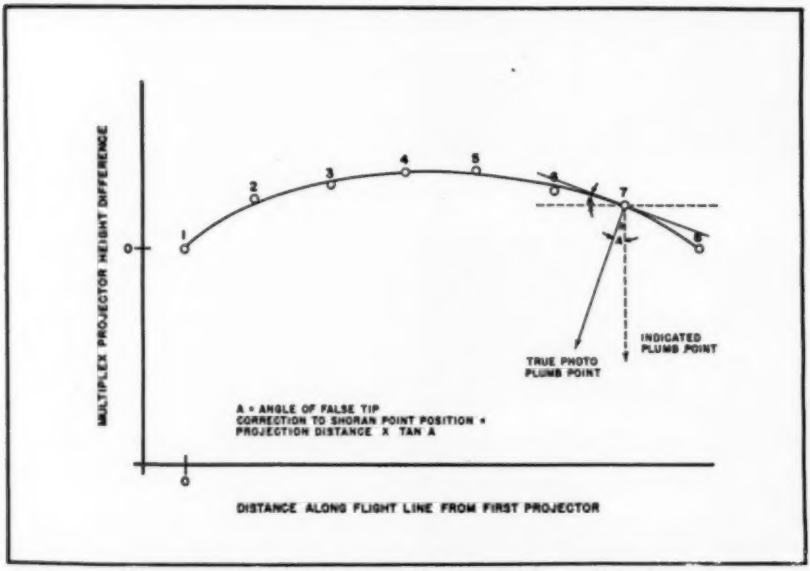


FIGURE 6.—"False tip" correction to multiplex nadir points.

Legal Descriptions From a Surveyor's Viewpoint

By W. B. WILLIAMS, R.L.S.

GRAND RAPIDS, MICH.

LAND SURVEYING is generally presumed to be an exact science, taught in colleges as a part of the engineering courses. Both assumptions are fallacious. Land surveying is not a major subject in any college; it is a cross between engineering and law.

Engineering is not an exact science either. Take, for example, the simple matter of the length of a line between two points several hundred feet part. If we send three pairs of skilled chainmen out to measure it on three different days, measuring to hundredths of a foot, we will get three different results. Even if we send the same party back to measure the line three times, at least one measurement will differ from the others. Why? Because differences in temperatures (steel expands and contracts); differences in pull, changing the amount of sag in the tape; differences in selection of points to measure from at the intermediate tape lengths; and failure to keep exactly on line will all affect the measurement to some degree.

Many of these factors can be, and frequently are, compensated for where the land values warrant the cost, but even then the results will not be exact. They will only be more nearly exact. They cannot be exact because theoretically a point has neither length, breadth, nor depth; and a surveyor cannot measure from or to something he cannot see. Accuracy in measurement is entirely relative.

Written descriptions can be so prepared, however, that they will give any degree of exactitude desired by the author. For example, I can say "Commencing at the northwest corner of section 19, thence east along the north line of said section 245 feet," "245.03 feet," "245.035 feet," "245.0347682 feet," or any other extreme I may be constrained to use. But, even within the bounds of reason, the failure to recognize the difference between the written word and the actual delineation on the ground is one very, very common cause of dispute over property lines.

Since legal descriptions are the basis of all holdings of real property, it is unfortunate that there is so little good literature on the subject. It appears to be one of those things that every reasonably intelligent person is assumed to know all about and so no one writes a book about it. Every legal text on the subject of conveyancing that I have seen has a chapter or two devoted to legal descriptions, as do engineering books on the subject of surveying. Two authors that I know of, Clark[1] and Skelton,[2] have written texts on the subject of boundaries that are good, particularly Clark who was a practising land surveyor before he studied law. The only really good primer on the preparation and interpretation of legal descriptions that I have ever seen came to my hands

Presented before the Bar Association of Grand Rapids, Mich.

[1] CLARK, FRANK E.: A Treatise on the Law of Surveying and Boundaries, Second edition, *The Bobbs-Merrill Company*, 1939, Indianapolis.

[2] SKELTON, RAY H.: The Legal Elements of Boundaries and Adjacent Properties, *The Bobbs-Merrill Company*, 1930, Indianapolis.

about a year ago as the gift of the author, Mr. William C. Wattles of California.

Most of our problems originate with the preparation of descriptions by people who either (1) do not recognize the fine differences in meanings of simple words, (2) do not go to the trouble of re-reading a description that they have drafted to see whether or not it could be interpreted to mean other than they intend, or (3) do not understand how the lands in Michigan and other States were originally laid out by the government surveyors and the practical problems involved in physically locating the land described.

As an example of the first, we have the frequent use of the cardinal directions, north, south, east, and west, which, without qualification, are ambiguous. Quite commonly we use them to mean lines parallel to the nearest section or street line, but they can equally well mean true north, that is, on a line passing through the starting point and the geographical north pole, or to the magnetic pole, that is, on a line passing through the starting point and the magnetic pole. Fortunately, in the vicinity of Grand Rapids the difference between the two is very slight at present; but, if the property in question is located 150 miles either east or west from Grand Rapids, the difference will be about 2 degrees, or 3.5 feet in 100 feet.

As an example of the second, we have descriptions such as: "The east half of lot 1, block 2 . . . except the west 5 feet thereof." The exception could apply to the east half only, to the entire lot, or to the block. The matter may seem absurd, but consider the case of a street only 50 feet wide platted along the west line of block 2. It was decided to widen this to 60 feet, and the owner of block 2 gave 5 feet toward the widening. Later, he sold "block 2, except the west 5 feet," and the grantee in turn sold lot 1, at the east end of the block, as "lot 1, block 2, except the west 5 feet" because the person who prepared the conveyance thought that he should keep it consistent with the instrument of acquisition. If it is desired to except 5 feet from the east half of lot 1, it should be described as the east —— feet of lot 1, or lot 1 except the west —— feet.

Another common example of this type of error is on sectional descriptions that read something like this: "The northeast quarter and the west half on the northeast quarter of section 1." Do they mean a 240 or a 120 acre parcel? It is like writing what you intend to be a friendly or a routine business letter and having the recipient call you back in a vile temper as soon as he receives it because he read into it something that you had no intention of saying or inferring.

A reading of the description by a second person or a critical reading of the typed copy will generally eliminate this type of error—but not always. We recently had a case in which there was a decided difference of opinion. The intent was to describe a 10-foot-wide strip off the easterly side of a lot located on the south side of a curved street, the side lines of the lot being NW to SE diagonals and roughly parallel and the south line being substantially an east-west line. I described it as "The easterly 10 feet, measured at right angles, of lot ——." If I had left out the phrase "measured at right angles," it would probably have been passed without question, but I wanted to be sure of where that 10 feet was to be measured, because 10 feet along the street line and along the south line would not have given a parcel 10 feet in width, as had been verbally agreed. However, the examining attorney felt that the phrase in question was indefinite and that the

line from which the right angle was taken should be mentioned. My position was that this was unnecessary in view of the fact we were describing the easterly 10 feet of the lot. This is probably an example of the exception that proves the rule.

The third source of difficulties, a lack of understanding of how the land in Michigan was originally laid out and of subsequent legislation and decisions regarding the acceptance of the "monuments" set at that time, is a rather broad subject to cover in a short article, but I will try to touch on those points with which the reader may not be familiar but which vitally affect the preparation of descriptions. A little history may not be amiss at this point.

After the Revolutionary War, the new Congress found itself deeply in debt to the men of the armed services who had made victory possible. Continental currency was almost valueless, and there was widespread dissatisfaction over settlement of debts. However, the great Northwest Territory had been ceded by England to the new nation, and since the economy of the times was based largely on agriculture, it was only natural for Congress to decide to pay the soldiers in land. It was orginally proposed in an Act passed by the Continental Congress in 1785 to make townships 7 miles square. However, the Act was amended a week later to make them 6 miles square, and that figure has since prevailed. In 1796, Congress passed an Act authorizing the establishment of a General Land Office and creating the office of Surveyor General, whose duty it was to cause the new lands of the West to be surveyed into townships and sections.

Contracts for running out the township boundaries were awarded separately from those for the subdivision of the townships into sections, the former probably to the more experienced surveyors. The procedure used for the township boundaries was to start at the southeast and southwest corners, as fixed by the survey of the next township south, and then measure north along the meridian lines 6 miles, setting and referencing stakes every half mile. The last stake was not referenced, as it was temporary and correct only for line. Since the northeast corner had been set on this line by the survey of the north boundary of the township to the east, a line was run west on about the parallel of latitude. Stakes were set every half mile until this line intersected the west meridian line. The intersection was the township corner, irrespective of the distance either way to the last corners set on the two lines.

The subdivision survey was made somewhat differently. Commencing at the southwest corner of section 36, a line was run north on the same compass bearing that was used for the east line of the township. A stake was set at 40 chains and another at 80 chains (1 mile), and then a line was run east, parallel to the south line of the township, to intersect the east town line. Stakes were set at the quarter corners as they were passed. Theoretically, the line should intersect the stake set for the northeast corner of section 36 on the boundary survey, but it seldom did. If it did happen to, the length of the last half mile was rarely an even 40 chains.

Apparently, there was no standard of accuracy prescribed in these early contracts, although we seldom find lines reported as being more than 81 or less than 79 chains long on interior sections. In 1902, an error of 33 feet in a mile was permissible, and in 1930 about 8 feet was the limit. However, the surveyors retraced each section line to reset the quarter corner on line half way between the two section corners. At least the notes made during this period say that this was done. The same procedure was followed as the surveyors moved north a mile,

then threw a tie line to the east, went north another mile, threw over another tie line, and so on until they ran the sixth mile north, where they intersected the north boundary. Here they set a stake on line, which formed the NW corner of section 1, and noted the distance from it to the stake set on the boundary survey. No point was set for the north quarter post as there was no necessity for a tie line to the east.

A similar procedure was followed for each succeeding mile line; starting at the south end of the township and running north, the surveyors tied in to the east every mile except at the north boundary. On the last line, the east line of section 31, after throwing the tie line east, they produced the same line west to the west township boundary. South of the Grand River, Mich., they simply intersected on the west line in the same way as on the north line. Between 1831 and 1837 the instructions were changed, however, and north of the Grand River, instead of intersecting the west line, they tied in to the corner previously set and reset the quarter post on line but did not, of course, correct for distance. The quarter post remained 40 chains from the northeast corner of the section.

That is how it was done in Kent County, according to the book, and it should have resulted in nice squares (almost) a mile long on each side except in the north and west tiers where, on the south and east, three-quarters of them should have been regular. As I mentioned before, certain tolerances were permitted, and certainly greater ones were taken. Why not? The land was cheap and the contracts were starvation cheap, a maximum of $3 per mile. Working conditions were rugged to say the least, and the possibility of the intensive use of the land that we know today could not have been predicted by anyone.

How does all this affect the writing and interpreting of legal descriptions today? We have a good example in my office right now. To simplify it somewhat, the description of a certain farm near the city states that the parcel commences 16 rods south of the west quarter post and runs east 50 rods and thence south 422 feet, west 50 rods, and north 422 feet to the beginning. North of this is a parcel that commences at the quarter post and goes east 50 rods, south 16 rods, west 50 rods, and north 16 rods to the beginning. Apparently there is no conflict between these decriptions, but, since the angle between the section line and the quarter line is 90° 17′ from south to east and since both descriptions have been platted with this angle shown in the bearings, the examining attorney for the purchaser of the lots in the first description contends that, because the boundaries are not perpendicular, the first description overlaps the second by an amount obtained by multiplying the sine of 0° 17′ by 825 feet, or about 4 feet at the east end of the property. Well, there are 320 rods in a mile, and 50 rods is to 320 rods as 4 feet is to 25.6 feet, which is about 40 links and well within the allowable error on the original survey.

I readily agree that the descriptions are not exact. No description that uses cardinal directions without qualifying them is exact. However, common practice from the beginning has been to assume that section and quarter lines are true cardinal lines, and in my opinion great weight must be given to this common understanding. Every surveyor and some attorneys know that these lines are not parallel and perpendicular, even though they appear to be in atlases and plat books; but I have yet to find a case on this point that has been carried to the Supreme Court, so I assume that our practice of turning on these cardinal directions, in the light of adjacent descriptions and our knowledge of how the original surveys

were made, has met with the general approval of the lower courts and the counselors of the law profession. If it had not, the records would be full of such cases.

I would like to make one other point in connection with the matter of inaccuracy of the original survey, and it applies equally well to city lots. In preparing descriptions for parcels being sold off from a parent description, the lawyer should always start the descriptions of the various parcels with distances from the same corner, and, if there is a residual parcel, describe it by excepting the summation of the parcels previously conveyed. Any surplus or shortage that may exist will thereby be placed in this residual parcel, and there will be no overlaps or residual strips between the descriptions of the other parcels. For the same reason, he should not use "the north 40 acres" of a quarter section when he means "the north one-quarter" or "the north 40 rods." All three cover slightly different parcels, the amount of difference depending upon the accuracy of the original survey.

These are all minor points. The great difficulties come when a layman drafts a property description and 50 years later an attorney tells the owner that he should have it surveyed for a better description. Then we get descriptions that read something like this: "Commencing in the center of the Fallasburg Road, 16 rods northeasterly along same from a point opposite the west edge of the Baptist Church parsonage as it stood in 1857 or before the west wing was built thereon"; or "Commencing in the center of Main Street, 100 feet west from a point marked by a hole filled with quick lime"; or "Commencing at an oak stake driven along a cedar pile on the south bank of the old channel of the Kalamazoo River" (there are probably a hundred or more piles along the south bank of the channel, and one would have to search all of them to find the oak stake); or "Starting from the north end of the west wing wall of the dam on Mill Creek" (which has since been washed out); or "Commencing in the center of the angeling road across section 10 where we two stood yesterday." With descriptions such as these, it is very necessary to use parol evidence, evidence aliunde, and considerable guesswork to locate the property.

Sometimes we have tied such points in to government corners and so have their locations; sometimes the maps that we have accumulated during 60 years of practice explain seeming inconsistencies in the calls of descriptions; and sometimes our knowledge of usual surveying practice is of some value in clarifying terms or expressions.

Any time that we can be of assistance, we shall be very glad to help.

❦ ❦ ❦

Sea is Vast Storehouse of Chemicals Needed for Life

A VAST, untapped storehouse of the chemical elements necessary to all life processes can be "mined" by going to the sea.

These elements can be obtained by direct extraction or by harvesting the animals and plants which have already extracted and concentrated them. Marine animals and plants can concentrate the life-vital elements found in the sea far better than any of the physical and chemical processes humans know how to use.

According to Dr. H. K. Benson, chairman of the Washington State Chemurgic Committee, analysis of marine products shows clearly that the plants and animals of the sea have an "amazing power" to separate from the sea almost all the chemicals that are involved in the processes that keep men and animals alive and nourished.—*Science News Letter,* April 28, 1951.

Conference of British Commonwealth and United States of America Survey Authorities

Mr. Earl G. Harrington of the Bureau of Land Management, as an official American delegate, represented the American Congress on Surveying and Mapping at the Conference of British Commonwealth and United States of America Survey Authorities in Wellington, N. Z., November 10 to 17, 1950.

The primary purpose of the conference, as indicated by R. G. Dick, Surveyor General for New Zealand and Conference chairman, in his opening address, was to discuss and work out certain reciprocal arrangements so that a registered and qualified land surveyor in one country could proceed to another country and practice his profession without having to qualify by taking an examination in that country. In other words, have standard examinations and qualifications for land surveyors in all countries. Mr. Dick stated in part as follows:

> Now, gentlemen, we have assembled here to endeavor to discuss and see by what ways and means we can accomplish some sort of reciprocity. . . . At the first session we should consider "The Surveyor": the functions performed by the surveyor, the definition of the duties carried out under each function, the grouping of functions into classes, a definition of a surveyor sufficient to embrace all spheres of activity and any other matters that any individual member represented here may wish to bring before our Conference.
>
> The second session we propose that we should discuss "The Qualification of the Surveyor"; that is, having come to some agreement on the functions that are performed by the surveyor, we would endeavor to see what type of qualification would be necessary for those functions. So that we would, I suggest, have to consider the pre-requisite educational standards, the academic examination standards, the type of training that such a candidate would require for qualification and the type of practical experience.
>
> Then the third session, which is the important session, must then be the outcome of our discussions and determinations on the qualification of the surveyor. I suggest after that we would have to discuss the relationship of the standards of qualification for different countries, the uniform and the fundamental principles of each qualification and then the forms of reciprocity that we are going to adopt. We cannot expect that we are going to have reciprocity. We have at the present time reciprocity between the Australian States and New Zealand, but it is not expected for one moment that we will be able to accomplish anything like full reciprocity, but we will be able to have some form, we hope, of reciprocity. We will have to recognize reciprocally the individual examining agencies and the methods of initiation of any reciprocal arrangements we might consider could be entered into.
>
> Now, it was not intended to extend our discussion anything beyond reciprocity in the initial stages, but there has been a desire expressed, particularly by the Royal Institution of Chartered Surveyors, that we should discuss the question of professional affiliation. We have represented here today members of the various institutions in Australia and New Zealand and the United Kingdom, and we have then added a fourth session termed affiliation, in which session we will have to determine the relationship of any affiliation by professional bodies to any reciprocal arrangements that may be entered into, the forms of membership that might be adopted by the professional institutions, the ethical standards we may even discuss as a professional brotherhood and fellowship, and the coordination of our professional interests.

The following resolutions adopted by the Conference emanated from the discussions at each session of the four subject matters outlined by Mr. Dick. There is no doubt that these resolutions express the thinking and the opinion of most of the representatives from the British Commonwealth countries.

A. THE SURVEYOR

(1) That the most suitable definition of Land Surveyor is: *One who measures and delineates the natural and artificial features of the earth.*

(2) That the above definition takes no account, and should take no account, of how well or by what means such measurements and delineations are made.

(3) That it is incumbent upon all who practice land surveying to maintain amongst themselves the highest standards of technical, professional and ethical practice of which they are capable.

(4) That the issue of a license to a surveyor and the conditions of its issue lie solely within the competence of the legislature of the country (State, Kingdom, etc.) which issues the license, or commission, though it frequently delegates its authority; and that a suitable definition of Licensed Surveyor is: *One who is licensed under an Act of the Legislature of a country to perform certain functions as defined in the Act.*

(5) That a land surveyor may be and often is called upon to perform a number of important functions which, although they do not fall within the definition of land surveying in paragraph (1) above, are nevertheless considered within his country to be part of the profession of Surveyor and which within his country a land surveyor may properly be called upon to perform. Examples of such functions are:

(*a*) Determining the uses and potentialities of land and natural resources.

(*b*) Determining the value of all descriptions of land, mineral, agricultural and house properties, and of the various interests therein.

(*c*) The practice of managing and developing estates.

(*d*) The practice of measuring and estimating artificers' works.

(*e*) The location and lay-out of structural and engineering works, including mines.

(*f*) Geophysical and geological surveys.

(6) That the functions of a land surveyor, as defined in paragraph (1) above, can generally be comprehended under the following main categories:

(*a*) Basic control and geodetic surveys, including astronomical, gravitational, trigonometrical, height, and electronic measurements.

(*b*) Topographic surveys, including instrumental, graphical, and air-photographic measurements.

(*c*) Large-scale detail surveys, including instrumental, optical, graphical, and chain measurements.

(*d*) Cadastral surveys, including the establishment of boundaries.

(*e*) Hydrographic surveys.

The above categories include the relative computations and preparation of diagrams, charts, maps, and plans necessary to their execution.

B. QUALIFICATIONS OF THE SURVEYOR

(1) That the surveying profession should encourage a high standard of general education amongst those it admits as students or probationers; and that in general this standard should not be less than that required for entry to the universities of the countries concerned, with a proper emphasis upon the English language (or such other language or languages as are used locally as the primary official language or languages of the country), mathematics and physics.

(2) That the surveying subjects, of which land surveyors should have a basic academic knowledge (either by whole time study or by apprenticeship) before undertaking responsible independent practice, should comprehend the following:

(*a*) Practical mathematics (land surveying)

(*b*) Astronomy

(*c*) Geodesy

(*d*) Engineering surveying

(*e*) Mapping

(*f*) Theory, use, and adjustment of surveying instruments
(*g*) Laws and regulations affecting surveys
(*h*) Field surveying practice (including plans of surveys)

Additional subjects such as the planning, utilization and valuation of land and other allied subjects to be left to the discretion of the countries concerned.

(3) That, as an indication of the standard of qualification which this Conference has in mind as being the minimum which it considers appropriate at the present time, it cites the following standard examinations simply as an example and not as an exclusive list:

United Kingdom	R.I.C.S. (Div. V)
Canada	Dominion Land Surveyors' Board
South Africa	Surveyor's Board
Australia	Surveyors' Boards
New Zealand	Survey Board

(4) That the period of training be generally 4 years. That of this period of training the student should have had a period of practical experience in a capacity in which he is personally responsible for the quality of his work; and that this period might generally be 2 years.

(5) That the education of a land surveyor should never cease but should continue through his career during which he may acquire broad or specialized knowledge and experience of great value to himself and his profession.

C. RECIPROCITY

(1) That Conference endorses the general principle of reciprocity.

(2) That reciprocity should be based on the functional principles and qualifications previously endorsed by this Conference.

(3) That further reciprocity must be at the discretion of examining, licensing and similar authorities of such countries as wish to enter into reciprocal arrangements on the lines of clauses (1) and (2) above.

(4) That the foregoing recommendations should be examined in the first instance by the appropriate authorities of the countries represented at Conference for investigation of the problems involved.

(5) That the participation of other countries of the British Commonwealth not represented at this Conference would be welcome.

(6) That the results of these investigations be forwarded to the nominee of the Conference for correlation and redistribution to the several authorities represented at this Conference.

(7) That in the interests of reciprocity a copy of the Conference resolutions be forwarded for the information of the British Commonwealth Survey Officers' Conference to be held in London in July 1951.

(8) That to facilitate reciprocity in the British Commonwealth of Nations and U.S.A. where no authority exists to control the qualifications and training of surveyors, all possible action should be encouraged by representatives to promote the establishment of such authority.

D. AFFILIATION

(1) That this Conference endorses the principle of affiliation but suggests that any action towards it can only be taken by the approach (by the general wish of its members) of one professional organization to another.

(2) That affiliation will probably best be effected on the following lines:

(*a*) Exchange of literature at headquarters level.

(*b*) Hospitality and use of reference library and headquarters' premises to members of affiliated bodies.

(*c*) Introductions both social and professional to surveyors from the visiting affiliated body to surveyors of the Home affiliated body.

(*d*) Exchange of local views and advice on professional matters as occasion arises.

(*e*) Advice to candidates for qualification as to the respective examinations of the affiliated bodies and as to employment.

(3) That this endorsement by the Conference is based upon the existence in each country of self-governing corporate bodies who insist upon a high degree of academic qualification and a high degree of professional integrity.

High-Speed Photographs

THE ARMY SIGNAL CORPS recently announced that engineers at the Research and Development Laboratories are developing new facsimile equipment designed to provide small front-line photographs of newspaper quality anywhere in the world within 5 minutes after the picture is taken. The projected method will permit faster sending of pictures and present clearer images on the receiving end.

Both graphic material and text may also be reproduced automatically on a mimeograph stencil, making hundreds of copies available in a matter of moments. The new equipment will provide a simplified system of loading copy, with push-button starting, and will introduce a device that will eliminate the necessity for continuous watching of the machine at the receiving end. There will also be a "fool-proof" method for reducing the effects of fading over poor radio circuits. Operation at three different speeds is made possible, compared with the one speed available with present equipment.

When used with poor radio circuits the machines will carry copy at 45 lines a minute; on average circuits the rate will be 90 lines, and on better-than-average circuits, 180 lines. Under most favorable conditions, the new equipment will have twice the speed of facsimile devices now in use.

Present Signal Corps equipment, handling copy 12 by 18 inches, is being used to transmit weather maps among the more than 250 weather stations making up the nation-wide network. Still in the planning stages is facsimile equipment that will cut down the transmission time to 7 seconds, accommodate copy larger than a double page newspaper spread, and many other advanced features, it was reported.—*New York Times*, April 1, 1951.

New Aid to Air Navigation

A NEW air navigational instrument of British make, which automatically shows the pilot the position of his aircraft, is shortly to pass from the experimental stage to mass production. Positions are indicated by the "navigator" by means of a needle moving about on a chart which progressively traces the course followed by the aircraft.

Described as a "Flight Log," the instrument consists of a chart set in a frame no larger than a box holding 100 cigarettes. The needle is controlled by radio waves sent out by a chain of stations and picked up by a receiver on board; the intersection of the wave lines shows the exact position of the aircraft. The instrument operates automatically and is not affected by weather conditions.

The automatic navigator is yet another addition to standard radio equipment already in use aboard a thousand ships and aircraft. Until now, the pilot has had to transfer data obtained from his instruments to a special chart in order to determine his position. With the "Flight Log," positions are indicated automatically. The chart may easily be secured to the instrument panel, as the section within view is only about 25 by 10 centimeters. The whole instrument, including the receiver and motive equipment, weighs only about 120 pounds.—*International Hydrographic Bulletin*, February 1951.

Altimetry—Its Present-Day Techniques

By LESTER E. DEMLER

SALES ENGINEER, WALLACE & TIERNAN PRODUCTS, INC.

SOME interesting uses of altimetry, taking full advantage of the time-saving feature of this method of surveying, have been made during the past decade.

For instance, the Magnolia Pipe Line Company of Dallas, Tex., constructed a pipe line from Texas to Illinois. It was necessary to obtain a profile of the location so the pumping stations would be properly situated. In order to save time, the profile was obtained by means of altimetry, using the *single-base method.* On this project, the base station was located at a bench mark as near as possible to the center of a day's travel along the route. A roving altimeter would start at each end of the line corresponding to a day's run and proceed toward the base altimeter, until the two roving altimeters met. In rough terrain encountered in the Ozarks, bench marks were few and far between and it was sometimes necessary to establish the base station as much as 15 miles from the route. The pumping stations were thus located according to the profile obtained by altimetry. Later, after the pipe line was completed, the line was re-run by spirit leveling and the average difference between the two profiles was found to be only 4 feet. The altimetry profile was obtained in one-quarter of the time required by the same crew which ran the spirit-level profile.

In preparing topographic maps from aerial photographs, a considerable number of supplemental-control elevations are required. Several government and private mapping agencies have used the *two-base method* of altimetry for obtaining vertical control which satisfies the requirements for 40-, and, in some instances, 20-foot contour maps. In addition to obtaining the control in a fraction of the time required by other methods, it is possible to obtain a considerable number of elevations useful to the photogrammetrist. One agency summarized 2 years' work with altimeters, and, where elevations were checked by other surveying methods, the differences amounted to less than 2 feet on 41 percent of the points, less than 5 feet on 75 percent of the points, and less than 10 feet on 95 percent of the points observed.

A 5-foot contour map covering 530 acres required only 276 man-hours for all operations, from preliminary reconnaissance to trial profile. Elevations determined by altimetry were marked directly on a 26-inch aerial photograph with a scale of 1 inch equals 200 feet, and the 5-foot contours were interpolated in the usual fashion. A test profile showed that 95 percent of the elevations checked were within one-half the contour interval.[1]

Aeronautical approach and landing charts, showing the elevations of airport obstructions to within 10 feet, were prepared by single-base altimetry during wartime, with a substantial saving of time and manpower.

Radio relay stations, which are used by the communications industry to transmit messages, must be located so there are no intervening obstacles between adjacent stations to impair the transmission. The preliminary location is selected from topographic maps, and the final location determined by altimetry, so that the station is erected at the most advantageous site. The elevation of the proposed

[1] SHARP, H. O. AND PALMER, R. K.: Faster and Cheaper Field Surveys, *Engineering News Record,* September 30, 1948. (Wallace & Tiernan Technical Reprint RA-2003A.)

location is determined with respect to a known point of elevation in the vicinity, usually a highway bench mark. The elevations of other prominences are determined and the best site selected. It is reported that undesirable locations might have been selected if altimetry had not been used, which would have required a substantial increase in construction costs. The elevations determined by altimetry are believed to be accurate to within 5 feet.

Altimetry is used extensively in geological and geophysical surveys. Geologists use altimeters to measure the depth of exposed rock strata and for reconnaissance. More accurate use is made of the altimeters in geophysical exploration where elevations are required to within 1 to 5 feet in order to adjust gravity and seismic surveys. In many areas it is impossible for spirit leveling parties to keep up with the geophysical parties; altimetry has speeded up the determination of elevations so that geophysical parties can proceed unhampered. This reduces field costs.

THEORY OF ALTIMETRY

The basic principle of altimetry is that the pressure caused by the weight of the column of air above the observer decreases as the observer rises in altitude. The relationship between pressure and altitude is not constant since air is compressible. Furthermore, changes in air density caused by variations in temperature, relative humidity, and gravity will change the pressure versus altitude ratio.

In order to eliminate the need for converting pressure readings to altitude, aneroid barometers are calibrated in feet and the mechanism designed so the pointer will deflect the same amount for equal changes in altitude. This provides a linear scale, and when calibrated in this fashion the instrument is properly called an altimeter. In order to calibrate an altimeter, a standard pressure-altitude relationship is used. Because altitude is relative to pressure, it should be stressed that the altimeter can be used only to measure difference in elevation with respect to some base or reference station, preferably a known point of elevation.

The pressure-altitude relationship holds good only for certain standard conditions. If these conditions do not exist while the survey is being made, corrections have to be applied. Temperature has the greatest effect on the density of air and is, therefore, the most significant. A correction for relative humidity is required only when high humidity occurs with high temperature. The temperature and humidity corrections are obtained from a chart supplied with the altimeter. The correction for gravity is insignificant and is rarely applied.

The air temperature correction should not be confused with the instrument temperature correction. The altimeter indication may change if the instrument temperature is altered, even though the atmospheric pressure remains constant. High-grade altimeters are compensated so that the correction is small and need not be applied unless temperatures at successive stations differ widely.

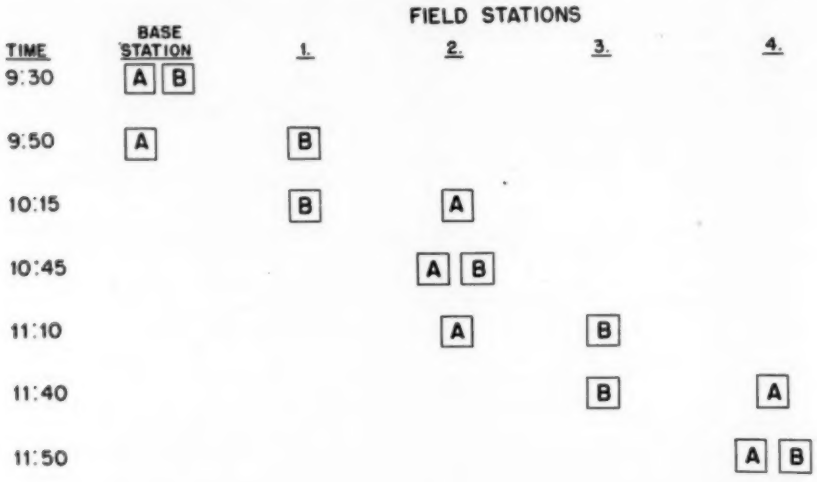
Barometric pressure changes will affect the altimeter just as altitude changes do. Since the atmosphere is continually changing, it is necessary to take the pressure changes into consideration. The success with which pressure changes are evaluated determines the accuracy of the altimeter survey. During inclement weather and when there are high, gusty winds, atmospheric conditions are very unstable and altimetry will not yield accurate results.

A thorough exposition of the theory of altimetry, and a comprehensive dis-

cussion of the performance of aneroid instruments, are given by W. G. Brombacher.[2]

LEAPFROG METHOD

A brand-new method of altimetry, called the *leapfrog method*, was devised recently by Bell Telephone Laboratories, and is illustrated in figure 1. The same temperature and relative humidity corrections are used for this method as are used in the single-base method, but the observational procedure is different. In the leapfrog method, two altimeters are read simultaneously at a base station. Then altimeter *A* remains at the base station while *B* advances to the first field station. The two altimeters are again read simultaneously, and the difference gives the elevation of the first field station after the appropriate temperature and relative humidity corrections are applied. Then altimeter *A* leaves the base station and leapfrogs the first field station and advances to the second field station. Meanwhile, altimeter *B* remains at the first field station and again the altimeters are read simultaneously. The difference in altitude reading is corrected and determines the elevation of the second field station with respect to the first field station. Then the altimeters are brought together at the second field station and read. After the comparison, altimeter *B* advances to the third field station; altimeter *A* leapfrogs to the fourth field station, and the altimeters are compared at the fourth field station. The survey may be speeded up by employing addi-



LEAPFROG METHOD

FIG. 1

[2] BROMBACHER, W. G.: Altitude by Measurement of Air Pressure and Temperature, *Journal of the Washington Academy of Sciences*, Vol. 34, 1944, No. 9. (Wallace & Tiernan Technical Reprint RA-1039.)

	NOVEMBER 21, 1949			NOVEMBER 22, 1949		
	NUMBER OF OBSERVATIONS	AVERAGE ERROR	MAXIMUM ERROR	NUMBER OF OBSERVATIONS	AVERAGE ERROR	MAXIMUM ERROR
SINGLE BASE	62	1.9 ft.	5.4 ft.	88	3.8 ft.	10.8 ft.
TWO BASE	32	1.9 ft.	4.4 ft.	44	3.2 ft.	9.3 ft.
LEAPFROG	10	0.6 ft.	1.5 ft.	16	1.2 ft.	4.7 ft.

TEST CONDUCTED BY A. T. & T., BELL TELEPHONE LABORATORIES, AND WALLACE & TIERNAN PRODUCTS, INC. IN THE VICINITY OF BALTIMORE, MD.

COMPARISON OF ALTIMETRY METHODS

FIG. 2

tional altimeters and by comparing altimeters at every third or fourth field station instead of at alternate stations. The advantage of the leapfrog method is that the altimeters are always close together and, therefore, operate under the same atmospheric conditions. This contrasts with the fixed-base methods, where the roving altimeters move away from the base altimeters and perhaps encounter pressure and temperature conditions different from those at the base altimeters. In effect, with the leapfrog method, the base station is carried along with the roving altimeters by comparison at alternate stations. Tests have shown that the leapfrog method will determine elevations with an average error of 1 foot and a maximum error of 4 feet where the two-base method yields an average error of 2.5 feet and a maximum error of 10 feet. A comparison of results obtained by the three altimetry methods is shown in figure 2.

SINGLE–BASE METHOD

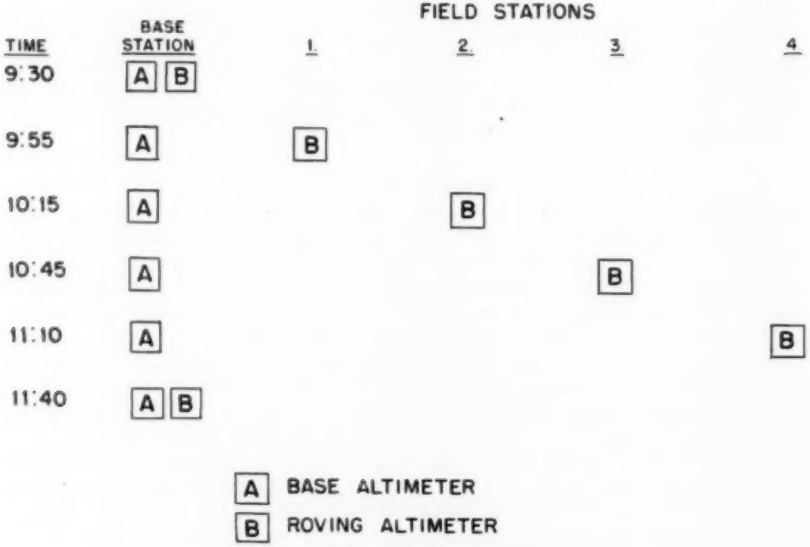
The single-base method of altimetry is illustrated in figure 3. One altimeter is stationed at a base and read at 5- or 10-minute intervals throughout the working day. Wet- and dry-bulb thermometer readings are taken at the base station. and significant changes in weather noted. A roving altimeter is read simultaneously with the base altimeter to determine the correction to the roving altimeter which will make them agree. Following the initial comparison, the roving altimeter advances to the first field station where the altitude reading, air temperature, and time of observation are recorded. Succeeding field stations are visited by the roving altimeter where the same data are obtained. At the end of the working period, the roving altimeter returns to the base station where a comparison is made against the base altimeter to check the initial correction. Several altimeters often operate from the same base station and this makes it possible to obtain additional observations at selected field stations, in order to check results.

To determine the elevation of a field station, the altitude reading is compared to the base altimeter reading which was taken at the time, and the difference in altitude calculated. The dry-bulb temperatures at the base station and the field station are averaged, and the relative humidity at the base station is determined

from the wet- and dry-bulb temperatures. The correction for temperature and humidity is obtained from the altimeter chart and applied to the altitude difference. The corrected altitude difference gives the elevation of the field station with respect to the base station. With the roving altimeter staying within 1,000 feet vertically and 15 miles horizontally of the base station, the single-base method will determine elevations with an average error of 5 feet and a maximum error of 18 feet. Decreasing the maximum elevation difference between roving and base altimeters to 200 or 300 feet will reduce the average error to 3 feet and the maximum error to 12 feet.

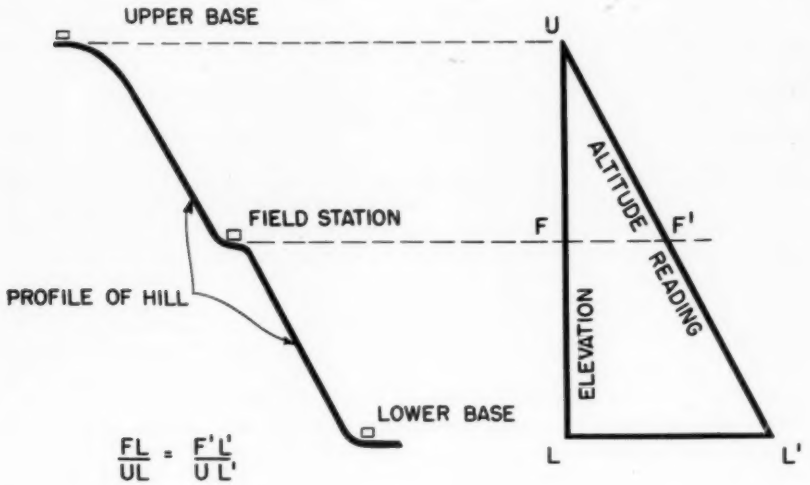
TWO-BASE METHOD

The two-base method, which was developed by Prof. Kissam at Princeton University a few years ago, is an altimetry procedure which does not require temperature and relative humidity corrections. Figure 4 illustrates the theory of the two-base method. One base station is established at a low point in the area being surveyed, and a second base station at a high point. The difference in elevation between the upper and lower base stations must be accurately known. Both bases are occupied with altimeters which are read simultaneously at frequent intervals. Roving altimeters then visit the points at which elevations are desired, and the altitude reading and time of observation are noted for each field station. To find the elevation of the field station, the difference in altitude readings taken simultaneously at the field station and the lower base, $F'\ L'$ in figure 4, is obtained, and so is the difference in altitude readings between upper and lower bases, $U\ L'$. Since the difference in elevation between bases $U\ L$ is known, a



SINGLE-BASE METHOD

FIG. 3



TWO BASE METHOD

FIG. 4

simple proportion yields the true difference in elevation between the field station and the lower base, *F L*.

The simultaneous reading of the base altimeters provides a continuous calibration of the air column over the area being surveyed against which the roving altimeter readings are compared. It is efficient to use several roving altimeters while the two bases are in operation. The two-base method will determine elevations with an average error of 3 feet and a maximum error of 10 feet, with the two bases separated as much as 1,000 feet vertically and 10 miles horizontally. Reducing the vertical separation to 200 feet and bringing the bases closer together will decrease the average error to 2 feet and the maximum error to 7 feet.

CONCLUSION

The revival of altimetry in the past decade came about just when surveyors and engineers were seeking ways of combating the high cost of field parties. Altimetry was adopted for a number of projects and produced elevations at a considerable saving in time and manpower. The adoption of new altimetry procedures such as the leapfrog method, and the development of new instruments, such as a recorder for base stations, will no doubt advance the use of altimetry further. There are probably many surveying requirements which, if analyzed with regard to the accuracy expected in the end result of a project, would be met with altimetry and benefit from reduced field costs.

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Metric Conversion Chart

A WALL CHART, 25 by 11 inches, for the rapid and accurate conversion of meters to feet and inches has recently been published by the Mayo Tunnel and Mine Equipment Company of Lancaster, Pa. The chart also has tables for converting feet and inches directly to meters, as well as constants for converting kilometers, kilograms, liters, metric tons, and horsepower. The chart should prove of great value to engineers stationed in, or destined for, countries employing the metric system. Copies may be obtained gratis from the company.—*The Military Engineer*, May–June 1951.

Electrical Prospecting

IMPROVED METHODS of "scientific prospecting" may result from a new electromagnetic model laboratory recently completed by the Institute of Geophysics on the Los Angeles campus of the University of California.

Under the direction of Dr. Louis B. Slichter, director of the Institute, research is aimed at increasing the efficiency by which ore bodies below the surface of the ground can be located.

The new piece of equipment, the only one of its type in the world, resembles an immense bath tub or a small swimming pool, 12 feet long, 7 feet wide, and 4 feet deep. Running lengthwise over the top of this concrete tank is a wooden track which supports (1) the measuring devices, (2) the electrical equipment, and (3) the ore body to be studied.

Actually, the tank is an electromagnetic model of the earth, although its appearance is far from the familiar round shape. Nearly any condition, so far as relative electrical conductivity of ore and earth is concerned, can be simulated inside the tank.

In electromagnetic prospecting, an electrical generator creates an oscillating magnetic field, which fills the surrounding space, just as the earth's steady magnetic field on a larger scale everywhere directs the compass needle.

When an electrically conducting ore body gets in the way of the oscillating field, the ore distorts the "flow lines" of the field, just as a large rock on the bottom of a stream deflects the current and causes a permanent ripple or wake at the surface.

The scientific prospector looks for the "electrical ripple" and so finds the conducting ore below which produces the ripple. Each ore body sends up a recognizable kind of ripple.—*Science News Letter*, April 28, 1951.

College Training in Land Surveying

By MILTON O. SCHMIDT

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URBANA, ILL.

INCREASED ACTIVITY among the members of the Property Surveys Division of the Congress and a quickening of interest in the preparation of a manual on land surveying offer an appropriate background for the discussion of some aspects of college training in land surveying.

It is to be doubted whether any department of civil engineering in this country professes that its graduates are universally qualified to execute skillfully the various steps in making land-transfer surveys in any region of the United States. Likewise, it is questionable whether any teacher of surveying would be so inept as to fail to tell his students that a measure of experience is indispensable in acquiring judgment and decision in the solution of any kind of engineering problem. However, the attrition of instruction in surveying and the frequent shallowness of its treatment emphasize the need to determine what minimum knowledge of land surveying the graduate in civil engineering ought to have. In appraising land surveying instruction we encounter conflicting academic interests not only in the Surveying Division but between divisions within the larger Civil Engineering Department.

These comments are not a claim for greater attention to be paid to the study of surveying but rather an invitation to consider land surveying in its relationship to professional civil engineering education. Hence, I shall treat this subject as a teacher of civil engineering rather than as an instructor in surveying.

What training the civil engineering student receives in land surveying should aim at making him cognizant of the problems in this field and the narrowness of his approach to their solution. His study of the ordinary surveying course, in which the elements of topographic, hydrographic, route, land, and control surveys are compounded, hardly qualifies him to do more. Hence, such land surveying treatment as may be incorporated in the course is not to be construed as training for primary service in this area of civil engineering.

Just as the practicing civil engineer should be able to discern the need for a consulting geologist on a special foundation problem, so he should recognize the need to invite the active participation of a qualified property surveyor in a new and unusual situation affecting important land-ownership rights. I recently heard about the unsatisfactory results of engaging a land surveyor to execute and maintain a highly precise record of subsidence measurements in an important industrial area. It would be just as fallacious to engage a civil engineer to make a property survey whose successful execution depended upon a thorough knowledge of land-line retracement procedures in a particular locality. However, since numerous civil engineers engage in the practice of highway and railroad engineering where problems affecting rights-of-way are common and in mapping projects where property and cadastral boundaries are frequently delineated, they should have some acquaintance with boundary problems and their adjudication.

Some exception might be taken to the stilted assertions of the land surveying practitioner who disclaims the possibility of the college-trained civil engineer doing anything well in the former's domain. Someone has said that nobody but

a land surveyor understands the work of a land surveyor. This could be warped to state that nobody understands a land surveyor unless possibly it be himself. The late Prof. J. S. Dodds,[1] one-time president of the Congress, once stated:

"We have found, after considerable research, that many land surveyors do not understand land surveying. They can measure roughly, dig carefully, run the instrument after a fashion, and compute closed traverses. Their record—in hundreds of volumes of 'Surveyors' Records' in the courthouses of Illinois, Iowa, Minnesota, Missouri, and Wisconsin—proves that they have not understood the art of land surveying."

At the last Illinois Surveying and Mapping Conferences at Urbana, one of the speakers on land surveys deplored the absence of University of Illinois civil engineering students. However, their absence is somewhat understandable if one considers the provisions of the act governing the registration of land surveyors in Illinois. As part of the instruction in land surveying, I thoroughly acquaint my students with legislation affecting registration as a land surveyor.

In the State of Illinois a person must fulfill the following requirements in order to be certified as a registered land surveyor:

(*a*) Be at least 21 years of age.
(*b*) Be a citizen of the United States.
(*c*) Be of good moral character and temperate habits.
(*d*) Have graduated from an approved high school.
(*e*) Have had five (5) years' experience in the practice of land surveying as an employee or principal.
(*f*) Have passed an examination.

There is no provision for substituting college training in civil engineering for any part of the required experience. This is an affront to the engineering college and its staff and is hardly calculated to interest any civil engineering graduate in the professional practice of land surveying. The act ignores the existence of the college and virtually negates the possibility of its performing a useful service to the community. Such perfidy will not make the prospect of a career in land surveying very enchanting.

Lack of unity among the land surveyors has engendered a condition of moral decay. Malpractice has rightly been condemned but continues unabated. F. C. Bond says[2]

"Land Surveying as an independent profession has deteriorated into a part-time or 'week-end' practice as a result of which irresponsible surveys and poor property maps are being produced. . . . In many areas much of the land surveying is done by municipal or state employees, working evenings or weekends, quite often using publicly owned equipment."

Most land surveyors have little interest in appraising themselves as to changes and progress in the art of surveying such as the use of State Plane Coordinates to perpetuate the positions of land corners. They lack professional pride and abhor the idea of sharing knowledge, and their ethics are not always beyond reproach. There are many civil engineers and men in other walks of life I could ask my students to emulate. But I could not urge the same for members

[1] DODDS, J. S.: The Importance of a Knowledge of Original Instructions in Making Public Land Resurveys, *Bulletin, Associated State Engineering Societies,* April 1936.

[2] BOND, FRANK C.: Let's Reform Land-Surveying Practice, *Engineering News-Record,* September 2, 1948, p. 69.

of this outworn guild which still possesses old ideas, short aims and lowly aspirations.

The subject of land surveying deserves its present although limited treatment in the usual surveying course of the civil engineering curriculum. Such study is, of course, only introductory. However, I can see no justification for more than this in the design of the 4-year engineering program, where the widest and fairest vision is needed to ascertain what is the best preparation for a career in engineering. Members of the land surveying profession, including those in the Congress, who have a real interest in future trends hardly need to be reminded that time is passing and that, since events of the past have not been conducive to attracting college men into their practice as assistants, or eventually as partners, the future holds no better promise than that which is extended to graduates by the profession. There is great need to infuse new blood into the land surveying profession. It lacks friends because is has been cool and unresponsive to new associations. It must espouse ventures that will elevate the very ordinary opinions that are held regarding it. It must breathe life, vigor, and enthusiasm or stop breathing forever. It must do much more in the immediate future than it has done for many years if it is to remain a profession.

Did I say profession? "O, let not virtue seek Remuneration for the thing it was. . ."[3]

[3] SHAKESPEARE, WILLIAM: Troilus and Cressida, Act III, Scene 3.

* * *

The Services and Collections of the Maps Division, the Library of Congress

THIS is an attractive pamphlet, prepared by Dr. Walter W. Ristow, Chief of the Division, which contains a large fund of information for anyone interested in maps, especially in cartographic history. The facilities and services available in the Division and the nature of the over-all collection, which includes outstanding historical as well as a complete file of modern maps, atlases, and globes, are described in detail. Although its primary responsibility is to provide a complete cartographic reference service to members of Congress and secondarily to the executive and judicial branches of the Government, the Division is open to the public. Anyone may inspect the maps or submit geographic or cartographic questions by mail or phone.

The remainder of the pamphlet is devoted to a description of the various special collections and outstanding individual maps, atlases, and globes which have been acquired by the Library. In making the acquisitions, emphasis has been placed on cartographic materials relating to the Americas, and it is estimated that 60 percent of the collection is made up of such items.

The pamphlet contains 21 pages and 17 half-tone plates consisting of views of parts of the Division and reproductions of some of the interesting map items. The book may be obtained from the Superintendent of Documents, Washington 25, D. C., at the price of $0.40.

The Application of Empirical Formulas to Property Surveys

By STANLEY M. SHARTLE, R.L.S.
SURVEYOR OF HENDRICKS COUNTY, INDIANA

WHEN the land surveyor is called upon to retrace and mark the boundaries of a lot in a very ancient town, or in one of its additions or subdivisions, his may be the most difficult task to be found in the profession. The young surveyor, as he examines the plat of the old town after having received his first assignment, might imagine his job to be as routine as staking out a rectangular building. And the land owner may wonder why the surveyor does not simply tape across his lot instead of measuring the entire neighborhood. Surprise and vexation sometimes follow when the price of such work is found to exceed the cost of a survey of a large farm. If the subdivision has been carefully surveyed and monumented in the beginning, and the plat thereof is accurate and complete, it is quite possible that enough of the old marks can be recovered and verified to simplify the work. This is more often the case in large cities, especially in recent subdivisions, than in rural communities where good surveys have been relatively few, and lines are sustained chiefly by private rather than public improvements.

Many of the old town sites and enlargements were laid out with little or no thought given to permanent monumentation, and in the few places where stones were set to designate certain corners the ravages of time have obliterated even most of these markings.[1] Where every original corner has been destroyed, and no corner inside or outside of the subdivision can be found which will serve as an indisputable point of departure for property surveys, the surveyor may have to rely entirely upon the evidence of the probable position of the old stakes as indicated by fences, posts, buildings, walls, curbs, etc., and upon the testimony of aged residents who claim to have a knowledge of the history of the evidence he may examine. If the community is very ancient and settled, but the evidence is widely scattered, indefinite, and discordant within itself and with the plat, the surveyor may tax his ingenuity and patience to the limit without having satisfied himself with his conclusion. There may seem to be a multitude of different locations for the same lot corner all of which appear to be equally satisfactory. On the other hand, the surveyor may be unable to find even one likely position for his lot corner which will agree with the evidence of any other.

VALUE OF SYSTEMATIC SURVEY ANALYSIS

Consistent with the statutes, judicial decisions, and other recognized rules and standards of practice, it is the duty of the surveyor to analyze the evidence systematically, reject that part which is positively unqualified, and balance the remainder by giving to each piece its share of the weight so that the survey will be based upon the most probable solution, or the one having the highest degree

[1] This refers to landmarks which were established in laying out the town, and not to section and related corners situated away from built-up areas. In Indiana, a remarkable number of the latter still exist in a perfect state of preservation; a few of the government bearing-trees of 1820 are living yet.

of harmony with the plat, obtainable from the evidence. When no original corners can be found, and no other corners have been permanently located and fixed by subsequent surveys made prior to the obliteration, any decision reached should be regarded as nothing but an estimate. However, every attempt should be made to achieve perfection, and the importance of skillful work and careful judgment cannot be overemphasized.

In the execution of such a survey, great care must be exercised in examining every property line for physical objects, and it is at this point that the surveyor should decide how much controlling weight should be assigned to each. Some boundaries may be entirely without visible demarcation, or their indication may be so vague that they are useless and should be disregarded. The control of the others will vary according to their visibility, permanence, stability, etc. For example, an indefinite row of bushes might be considered inferior to a line marked by a definite, but very old, fence. As it may be desirable to retain both observations, weights will have to be assigned to each so that their influence upon the final solution will be proportional to their relative values. By estimation alone the fence might deserve a rating three times higher than the row of bushes, so the weights could be stated as 3 and 1.

ADJUSTMENT BY THE METHOD OF LEAST SQUARES

The writer has used his correlated method of analyzing notes collected on surveys of this type a number of times with much success. As it involves an adjustment by the Method of Least Squares it is somewhat laborious, but has proved to be a powerful tool in producing without guesswork a result which is theoretically the best value obtainable from the data. The solution is accomplished by determining, from the field notes, an empirical formula of a straight line. This involves the formation and solution of two normal equations; if done on a calculating machine, the whole procedure can be performed easily by an assistant. It is a task which is certainly justified on important surveys where it is imperative that the final location be as near to the truth as the evidence will allow. This system becomes mechanical when one is familiar with it, and is unique in that when the field note data are tabulated in a convenient form for solution, vast amounts can be processed simultaneously without the exertion of prudence beyond that required in the computations themselves.

It should be understood that, while the application of empirical formulas appears to be appropriate in specific cases, there are many where the presumption is overcome by facts which establish the early platter's intention to be the reverse. A street or alley indicated on the plat and found on the ground to be permanently laid out and fixed to its platted width may overcome the method. Furthermore, possession, improvements, undimensioned lots on the plat, or lines previously established by the court may limit such a rule. In cases of this nature the indiscriminate use of formulas might needlessly unsettle many recognized and acknowledged boundaries and would be inexcusable. Another limiting feature is the time consumed in the calculations, and the ultimate cost to the client.

Aside from these limiting cases there are many which are particularly well suited to the formula method. When all other systems have failed, and the case is without the limitations described above, empirical formulas will probably produce the highest degree of accuracy which can be attained. Cases of this type are the ones under discussion here.

USE OF EMPIRICAL FORMULAS

In this method, the values of a certain function corresponding to known values of its independent variable are computed and the relation between the function and the variable is expressed in the form of an equation. The distance along the direction of progress of measurement, as found by summing the platted widths of the lots, streets, and alleys from a particular line of the subdivision (preferably one of the exterior boundaries which may have been the place where the old survey commenced), is the independent variable x. Therefore, x may represent the station numbers assigned to all lot, street, and alley lines, by using their spacing as recited on the plat reckoned from one side of the subdivision to the other. Actual measurement over the route from an arbitrarily chosen point near $x = 0$ will demonstrate in almost every instance that the physical appurtenances of the land lines are not spaced in a uniform plan, as the plat would imply. Presupposing that no blunders were made in the original laying out, the differences between the modern and the ancient measurements are the result of the influences of systematic and accidental errors arising from the chain of the early survey as it differed in standard length from the modern tape, and the gradual displacement of the lines of occupation from the original staked lines as their obliteration increased through the years. While the systematic errors are a function of x, it is not essential that the accidental errors have any such relation. These differences between measurements are denoted by y' and are the dependent variables.

An approximate solution may be obtained by plotting these variables as rectangular coordinates, representing the values of the function y' as ordinates, and those of the independent variable x as abscissas, each point thus plotted corresponding to one comparison or observation. A straight line is then drawn so as to follow the plotted points as nearly as practicable. The weights of the observations as plotted on the graph can be differentiated by letting a value of weight 1 be indicated by a single dot; an observation of weight 2 by a dot within a circle; of weight 3 by a dot within two concentric circles, etc. As shown in figure 2, it is convenient to exaggerate the vertical scale, as is done in plotting profiles from leveling.

The general form of the equation which is applicable to problems of this nature is known from theoretical considerations to be that of a straight line, namely,

$$y = mx + b \quad \text{or} \quad mx + b - y = 0$$

where the slope m represents the excess or deficiency in the original survey expressed as a coefficient of x, and b is the y-intercept or the distance between the true point $x = 0$ and the arbitrarily chosen point of beginning of the new measurement.

If we make algebraic statements of the separate observations by substituting the observed data in the latter form, we produce the observation equations

$x_1M + B - y'_1 = 0$	Weight w_1
$x_2M + B - y'_2 = 0$	Weight w_2
$x_3M + B - y'_3 = 0$	Weight w_3
.....	.....
$x_nM + B - y'_n = 0$	Weight w_n

where M and B are to be determined.

For the sake of simplicity, no demonstration of the theory or principles of least squares is given. Only a knowledge of the mechanics of the process is necessary for its application.

From the above observation equations two equations, called normals, will be formed, and since they are always the same in number as the unknown quantities no more than two of these normal equations are essential irrespective of the number of observations. Letting square brackets indicate the sum of all such terms as are included by them, we have for the normal equations

$$[wxx]M + [wx]B - [wxy'] = 0 \quad (1)$$

$$[wx]M + [w]B - [wy'] = 0 \quad (2)$$

which may be solved simultaneously to determine M and B.

The first equation is formed as follows: Multiply the first observation equation by w_1x_1; the second by w_2x_2; etc.; and add all of the resulting equations. The second normal is formed by multiplying each observation equation by its weight, w, and adding.

EXAMPLE OF FIELD WORK

Let figure 1 represent part of a plat of a hypothetical subdivision laid out 100 years ago, and suppose that search has failed to recover any survey monuments

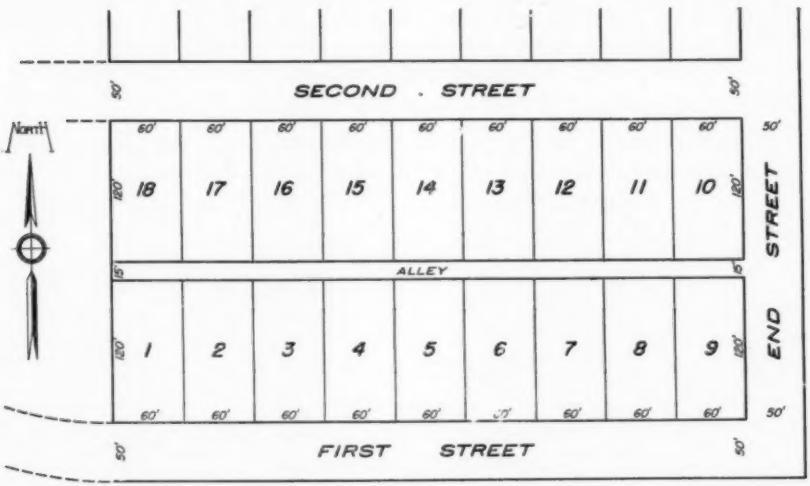


FIGURE 1

inside or outside of the area and that all efforts to locate them from section corners or from deeds of contiguous tracts have been futile.

The notes that follow, being abbreviated, are designed to display the manner in which the field work might commence, rather than serve as an exhibit of standard note keeping.

Measured east along approximate north line of First Street:

Wt.	x Plat	x' Meas.	y' Diff.	$x+y$ Final*	Remarks
1	0	0.0	0.0	+0.73	Center of new post for SW corner lot 1.
4	60	61.2	+1.2	60.92	Very old fence bearing northward
2	120	121.0	+1.0	121.12	Old wood stake of unknown origin
3	180	181.1	+1.1	181.31	Notch in walk and old post north
1	240	241.8	+1.8	241.50	Row of shrubs north
0	300			301.70	Unmarked
4	360	362.0	+2.0	361.89	West edge of ancient brick wall
1	420	421.9	+1.9	422.09	In line with new fence northward
1	480	480.4	+0.4	482.28	Row of bushes, rather indefinite
2	540	542.6	+2.6	542.47	SE corner of stone column
3	590	592.5	+2.5	592.63	Old fence for east line of End Street.

* This column should be filled in after the adjustment of the entire subdivision has been completed. However, for the purpose of this example, the quantities presented are those derived from the empirical formula of this particular line.

When plotting the values for x and y' by the method already described, one can see at a glance the position of each object relative to every other (fig. 2). Furthermore, it is obvious that the points tend to approximate a straight line, as AB. This line can be tentatively located by estimation, that is, by endeavoring to find an "average" through them. The point for $x' = 480.4$ should be rejected because it is so discordant among the others of the series that it is undoubtedly unreliable. The point for $x' = 0$ is of questionable worth, but shall be retained with low weight. The question of rejection is sometimes difficult, and unless impartiality and good judgment are exercised the very foundation of a good survey may be vitiated.

The observation equations will then be as follows:

$B - 0.0 = 0$	Weight 1
$60M + B - 1.2 = 0$	" 4
$120M + B - 1.0 = 0$	" 2
$180M + B - 1.1 = 0$	" 3
$240M + B - 1.8 = 0$	" 1
$360M + B - 2.0 = 0$	" 4
$420M + B - 1.9 = 0$	" 1
$540M + B - 2.6 = 0$	" 2
$590M + B - 2.5 = 0$	" 3

The normal equations will then become

$$2520300M + 5970B - 12465.0 = 0 \quad (1)$$

$$5970M + 21B - 34.5 = 0 \quad (2)$$

and their solution gives $M = +0.003228$ . . . and $B = +0.7252$ . . . , so that the required empirical formula is, therefore,

$$y = 0.003228x + 0.73.$$

The quantities for the "final" column can be computed by adding to x the corresponding value of y as found in the above formula, or may be calculated from the following convenient form:

$$x + y = 1.003228x + 0.73.$$

Interpreted, these formulas mean that there is a surplus of land amounting to 0.3228 percent over that indicated on the plat. Had the M been negative, a deficiency would have been present. Furthermore, the positive constant term signifies that the measurement in the current survey began 0.73 foot too far west.

When locating lot corners, the use of the quantities in the "final" column, being reckoned from the first measurement, is preferred to advancing the beginning point 0.73 foot east, recalculating and remeasuring.

To complete the survey in the example, a straight line should be run through the arbitrary point $x' = 0$ approximately parallel to the west line of the subdivision. From this base line, measurements similar to one already exhibited and studied here should be made eastward along the alley (fig. 1) as well as along both margins of Second Street. No two of the empirical formulas resulting from these additional tapings will be exactly identical, and therefore no uniformity can be achieved in the analysis until one equation has been derived therefrom which will provide maximum harmony with the evidence gathered from all over the area. The most probable value of the quantity m in this comprehensive formula is denoted by the symbol M_o and can be taken as the weighted mean of the M's in the individual empirical formulas, these weights being determined either from $[w]$ of each normal, or from the probable error of each formula as might be computed by least squares. Likewise, the discordant b-terms must be reconciled, and this should be accomplished by another, but wholly separate, empirical formula adjustment.

The change of M in the individual formulas to correspond with the weighted mean M_o in the comprehensive formula alters the slope of the lines on the various graphs. This in turn will require a change in the b-terms. To do this, each line should be rotated about that point therein which will provide the most probable value of the term after rotation has been effected. This optimum point is chosen automatically, and the correction C which is to be applied to B can be ascertained by the following formula:

$$C = -\frac{[wx]}{[w]}(M_o - M).$$

Some surveyors, when apportioning excess or deficiency over more than one

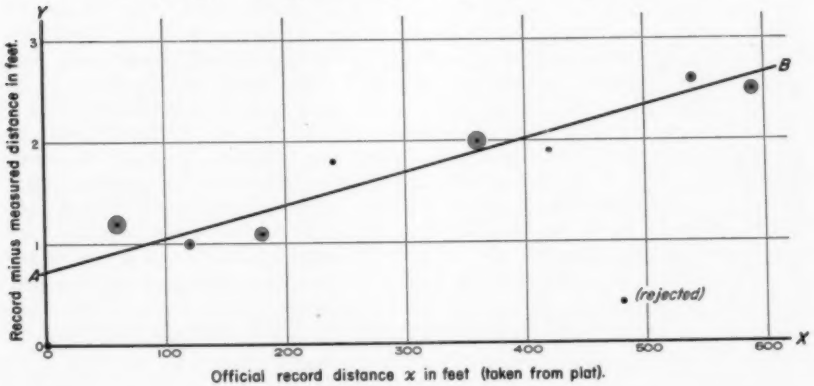


FIGURE 2

block, apply same to streets and alleys as well as to the lots, while others hold that apportionment should be confined to the lots. When the first rule is employed, the customary mode of measuring and stationing will prevail. But if the latter rule is applied, the stationing should be carried out as though no streets or alleys exist. Thus, the x-value of one side of a street will be the same as the other side, since its width is omitted from the stationing.

After having derived the best formula for longitudinal control, one should deduce a similar control in latitude. Since there are but two accessible avenues for measurement, namely, along the east and west sides, much of the data available in the central portion would remain neglected by our conventional longitude process. Accordingly, a straight line can be run out along the approximate centerline of First Street, and lines parallel thereto, at known distances from it, should be established near the centerline of both the alley and Second Street. Boundary evidence on both sides is then tied to these three lines by measurements, and from these data three distinct empirical formulas for latitudinal control are formed. A comprehensive latitudinal formula may be created from these by adjusting the m's and b's to harmonize as before.

* * *

Computer Aids Defense

THE LARGEST and most accurate electronic analogue computer ever built to evaluate the performance of guided missiles, ships, airplanes, and submarines and aid in the air protection of American cities was shown in operation for the first time at a recent Navy Special Devices Center-Radio Corporation of America demonstration at Princeton, N. J.

"Designated 'Project Typhoon,' the new electronic computer is expected to save many millions of dollars in the design of guided missiles and also to solve many riddles encountered in the air defense of our cities," said Dr. C. B. Jolliffe, Executive Vice President in Charge of RCA Laboratories Division. "Complex simulated problems of a complete guided missile system which other computers are too small or too inaccurate to handle effectively can be solved by Typhoon. This will enable the design of equipment with a minimum of experiments that would require expensive apparatus, such as missiles, airplanes, and ships."

Dr. Jolliffe predicted that the RCA electronic analogue computer will play a significant role in military science of the future. Very often the construction of an experimental guided missile may cost more than $100,000, he pointed out, and unless its characteristics are properly checked in advance by accurate computing techniques, actual launchings may be failures resulting in the loss of instruments and apparatus. With Typhoon, he added, any missile problem can be solved over and over, with the characteristics varied each time until the desired results are obtained. Thus, by avoiding costly trial and error tests, the new computer can, with a high degree of accuracy, assure scientists how a proposed missile will react under actual flight conditions.—*Army Navy Air Force Journal*, November 25, 1950.

175 Years of the Official Mapping of the United States

By W. L. G. JOERG

CHIEF OF THE CARTOGRAPHIC BRANCH, NATIONAL ARCHIVES

ABANDONING the customary device of speaking *off* the record—which has so many valid uses in achieving objectives directly without roundabout formality—I should like to review rapidly the story of topographic mapping in the United States during the 175 years of our national existence. It is impossible to do full justice to the subject in this short paper, but it is hoped, nevertheless, to emphasize some of the major stages and to recall some of the outstanding topographic maps produced during those stages. Aside from their historical interest, many of these old maps still serve practical purposes. In many cases, they supply information important to the oil man, the railroad company, the surveyor, the land owner, the title company, and the entire range of Federal agencies whose work, in one way or another, is tied in with the land.

Many of the maps that relate to the history of the topographic mapping of the country are now in the National Archives, which was established 16 years ago to preserve the permanently valuable records of the Federal Government. The maps are kept in the Cartographic Records Branch; field books and journals are kept in other units of the agency.

An interesting exhibit of some of these outstanding documents is being displayed at the National Archives, in connection with the present meeting of the Congress on Surveying and Mapping. The exhibit was organized and prepared by Herman R. Friis, Assistant Chief of the Cartographic Records Branch, aided by Mr. J. F. Winkler. To both I am indebted in the preparation of this paper. In the same Exhibition Hall are displayed the Nation's documentary treasures that have traveled widely throughout the country as the Freedom Train Exhibit. Countless American citizens have been thrilled at seeing for the first time these basic documents which have shaped and are still shaping our lives.

The United States did not enter upon its national existence devoid of official mapping. Fairly large maps existed for a number of the Colonies. These had been made under the British regime and embodied the knowledge of the time. Some were based on actual surveys—notably, the well-known map of Virginia and Maryland by Joshua Fry and Peter Jefferson (Thomas' father), the map of North Carolina by Captain Collet, the map of Florida by Bernard Romans, and that of New York by Capt. Samuel Holland. Also available were the excellent coast charts by De Brahn in his *Atlantic Pilot* and the superb charts in the *Atlantic Neptune* by Des Barres.

Wars cannot be fought efficiently without adequate map representation of the theaters of operations. This was just as true at the birth of our Nation as it is today. After the first full year of the Revolutionary War in which large bodies of troops were moved over relatively long distances, in January 1777, Washington urgently brought the need for adequate maps to the attention of Congress. The pertinent passage in Washington's letter, from which the beginning of national topographic mapping may perhaps be dated, reads as follows:

"The want of accurate maps of the country which has hitherto been the scene of war has been of great disadvantage to me. I have in vain endeavored to procure them, and have been obliged to make shift with such sketches as I could trace out from my own observations and that of gentlemen around me . . . I really think if gentlemen of known character and probity could be employed in making maps (from actual survey) of the roads, rivers, bridges and fords over them, the mountains and passes through them, it would be of the greatest advantage."

Before the summer campaigns were well under way the Continental Congress passed a resolution "that General Washington be empowered to appoint Mr. Robert Erskine, or any other person that he may think proper, geographer and surveyor, to take sketches of the country." Three days later, Washington offered the appointment to Mr. Erskine, who promptly accepted.

Robert Erskine thus became the first of a long line of men who mapped the country. His position was the nucleus from which later developed both the Topographical Corps of the Army and the General Land Office. In the 3 short years before his death in November 1780, Erskine prepared maps of the operation areas from the Highlands of the Hudson to Philadelphia, concentrating most of the mapping in upland New Jersey. Simeon De Witt was appointed his successor as geographer to the main army. In July 1781 a new position of geographer to the southern army was added, to which Thomas Hutchins was appointed.

One important problem that confronted the new nation when the war ended was the control and orderly disposal of the public domain. To achieve this, Congress in 1785 passed an ordinance "for ascertaining the mode of disposing of the land in the western territory." This made provision for the rectangular township system of surveying and subdividing the public lands which has continued to this day. Thomas Hutchins, as "Geographer of the United States," continued in office as Surveyor General of the public lands.

The Ordinance of 1785 prescribed that the first area to be surveyed extend an east-west distance of seven ranges from the initial point at the intersection of the Ohio River with the western boundary of Pennsylvania. It provided that "The Geographer shall personally attend to the running of the first east-west line." The resulting area is known as the original Seven Ranges and its northern limit as the Geographers' Line. The original plats, about 75 in number, are in the National Archives, transferred from the General Land Office.

There is a wealth of historical interest in so important a map series as the township plats, which cover the greater part of the entire area from the Appalachians to the Pacific. Time, unfortunately, limits discussion. Normally, three copies were drawn of each plat—one for the central office in Washington, one for the office of the surveyor general of the land district, and one for the local land office. As the local offices were progressively closed in the districts in which the public lands had been entirely disposed of, the plats were usually returned to Washington headquarters. In some cases, the State governments made use of the opportunity given them of acquiring the plats relating to their areas. Of the plats sent to headquarters, those of 12 states were transferred to the National Archives by the General Land Office. Most of these are bound in platbooks, each of which is assigned a volume number in a series limited to the given state. Calls for these plats are made only in terms of township and range numbers referred to principal meridians and base parallels. To facilitate filing, the Cartographic Records Branch has developed a new kind of index map. This

is drawn on quadratic section paper with each square representing a township. The meridians and parallels are appropriately laid off and numbered. In each square is written the number designation of the volume, or volumes, in which the given plat may be found. This scheme was devised and put into practice by James A. Minogue, now geographer in the Department of the Army, when he was a member of our staff.

Besides serving as legal references, the township plats are sources for historical and scholarly research. The date of preemption of a fractional part of a township reflects its date of settlement. A chronological series of maps of the entire public domain showing year by year the sections and quarter sections preempted would present a factual and realistic picture of the settlement of the public lands of the country. Such a series, of course, is unavailable. Yet much can be determined from the fragments which are available. From such fragments in the National Archives, a scholarly doctor's dissertation is being prepared as a pilot study in the Department of Geography of the University of Maryland. This shows the year by year occupance of an east-west county belt across Kansas from the beginning of the disposal of public land in that State in the 1850's to the present time.

A mapping undertaking that follows next in chronological sequence is especially interesting because of the role it played in a recent litigation. A case between the State of New York and a public utility company hinged on whether a certain old dam at Ticonderoga controlling the outlet waters of Lake George had existed before a given year. Search among the maps transferred to the Archives from the Corps of Engineers disclosed a work sheet of a survey of that area which showed the dam as constructed and functioning. The survey was obviously old but undated. A further search in the letter books in the War Records Branch of the National Archives found the report on the survey which had been sent by Major Roberdeau of the Topographical Engineers to the Chief of Engineers. The survey was made necessary by our experience in the War of 1812 and formed part of a reexamination of the land defenses of our northern frontier from Lake Champlain to Mackinac. Through the report it was evident that the survey had been made in July 1815. This was of salient importance to the attorneys for the utility company. Confirmation of the importance of the information came later in the form of a long distance telephone call from the office of the Assistant Attorney General of the State of New York, requesting a photostat of the map. This case is a good example of a type of service that the National Archives can and does render.

A mapping activity which has continued practically through our entire history is the survey of our national boundaries. While the objective was to define a line on the ground, the surveys necessarily included belts of territory straddling the line. These varied in width depending upon knowledge of the approximate location of the line. Some of the earlier surveys especially embraced irregular areas of wide extent. An example is the survey made in connection with the Northeastern Boundary controversy inherited from the peace treaty of 1783. This was not settled until 1842 when the Webster-Ashburton Treaty was approved. In 1840 Congress directed that surveys be made to define the divides involved in the problem. Surveys were made of the divides separating the drainage flowing into the St. Lawrence River, the Gulf of St. Lawrence, the Bay of Fundy, and the open Atlantic. The maps of these surveys were never pub-

lished, however, since the dispute was settled amicably by Webster's rectilinear solution.

The State Department has deposited these surveys in the National Archives, together with the original surveys and published maps of the other international boundary surveys made before 1906. These include surveys for: The Great Lakes boundary, the 49th Parallel, the land and Rio Grande boundaries with Mexico, and the Alaskan boundary.

An interesting group of surveys are the so-called "internal improvement surveys" of the 1820's and 1830's. These deal mainly with harbor improvements and proposed canals; a few deal with proposed railroads. That the object of some of these surveys was visionary is evident by the nature of the projects under consideration. Surveys were made for a cross-Florida canal, an Ohio River-Lake Erie connection, and a canalization of a stretch of the Tennessee River at Muscle Shoals.

Although established sometime prior, it was not until the 1830's that the Coast and Geodetic Survey began its systematic surveys of the land and water of our country's coastal strips. The many accurate navigational charts which resulted are characteristic of the many contributions made by this agency during the past 120 years. One small item reflects the mastery of its older material. This is a series of index maps which indicate by consecutive periods the extent, scale, and date of the various original hydrographic surveys made by the agency. The indexes include some 20 segments of the Atlantic coast and 12 segments of the Gulf coast. The original indexes are preserved in the Coast and Geodetic Survey. Similar indexes for the Pacific are understood to be in preparation.

Another series that covers a long period of our history is the series of plans of forts and fortifications, particularly on the sea coast, ranging from 1792 to 1900. These plans were recently deposited in the Archives by the Office of the Chief of Engineers. The plans are not primarily topographic maps although many contain topographic detail. Certain of these plans have proved of great value to the National Park Service in its program of recommending transfer of historic monuments to the respective States. Fort Moultrie, S. C., and Fort Macon, N. C., are recent cases in point. The series has also demonstrated its value in connection with the current reconstruction of the Battery at the tip of Manhattan Island.

The mapping activities so far described relate mainly to the area east of the Mississippi. The adventurous part of the story of our mapping begins with and unfolds concurrently with the "Conquest of the Golden West." The story of exploration and discovery of the globe is fascinating and to us the development of the West makes the most thrilling chapter. Among the outstanding names in western mapping from 1804 to 1850 are those of Lewis and Clark, Pike, Long, Fremont, and Stansbury. Unfortunately, time does not allow a description of the mapping and accompanying adventures of these early map makers. The original maps and fieldbooks from practically all of their journeys, however, are in the Archives and would provide a wealth of material for a "best seller." An engrossing chapter could be developed from the fieldbooks that Pike had with him when he was taken into captivity by the Spanish authorities north of Santa Fe in 1807.

There immediately followed the period 1853–1855 of the Pacific Railroad surveys—that masterly undertaking that threw four parallel strands of measure-

ment across the intervening 1,500 miles to the Pacific and laid the groundwork for the later linking rails of steel. The eleven quarto volumes in which these surveys are reported remain a classic in their field. In the last volume there is that model memoir, which accompanied his 1:3,000,000 scale map, by Lt. G. K. Warren of the Topographical Corps of the U. S. Army. This is an account of the method of compiling the map and a description of the source maps used. The 1857 map, frequently revised, remained the standard for the area for over twenty years.

The war between the states, true to the pattern of all wars, stimulated mapping. This resulted mainly in scattered coverage since efforts were necessarily concentrated on critical areas. Nevertheless, several systematic series emerged—notably those of central Virginia on scales ranging from 2 to 8 inches to the mile by the Union engineers and the so-called "Lost Maps of the Confederacy," now in the Virginia Historical Society in Richmond and the Library of Congress. The Confederate maps were mainly of counties of Virginia at the scale of 1:80,000 and were patterned after the European model of the time, the French Carte d'Etat Major. Some of the sheets of the 8-inch series are models of clarity, especially in urban areas where they take on an almost cadastral character.

The end of the war brought a renewal of the surveys for the railroads which set the pace for the expansion of the West. The original maps—with the Secretary of the Interior's authorizing signature—of most of the surveys of the land-grant railroads are now in the National Archives. They are constantly in demand by railroad attorneys and engineers and serve as a source for valuable information.

Another mapping aspect worthy of note in this period is represented by the valuable maps compiled and published by the various regional military departments in the West. Many of these were the best extant representations of their respective areas and were on relatively large scales. They were constantly amplified and revised by new route surveys and cavalry patrols, often carried out in Indian campaigns. Some even attained the status of sectional sets.

The final mass endeavor of this period of western mapping consisted of four surveys in the 1870's known briefly by the names of their directors—Hayden, King, Powell, and Wheeler. Two were sent out by the Department of the Interior, two by the War Department. These surveys produced a mighty body of information in text and maps that threw the clear light of knowledge on the topography, geology, and land classification of the West. Many of the reports are classic. But in the zeal of the undertakings inevitable overlaps occurred. These led to inquiries by Congress that culminated in a request for a report by the National Academy of Sciences. Powell's report to the Secretary of the Interior in April 1878, Wheeler's caustic comments in the final report of his survey, and the findings of the Academy still provide interesting reading, administratively and professionally.

The rest of the story is a familiar one. In 1879 the Geological Survey was established and the systematic topographic mapping of the country developed as one of its primary functions. Mention must also be made of the many valuable contributions in this field of the Corps of Engineers, the U. S. Coast and Geodetic Survey, the U. S. Forest Service, and the Tennessee Valley Authority. Striking progress has been made since that year—and even since the early days

of the century when, for example, no topographic sheets existed of certain areas within 50 miles of metropolitan New York—to the present when we revel in the luxury of European detail in 1 : 24,000 east of the 78th meridian.

This brings to an end our rapid review of the story of 175 years of mapping of the United States—a review telescopic in quality since it intentionally magnified the more distant, less familiar scene at the expense of the nearer, better-known foreground. It also attempted to point out that many of the significant documents are in the National Archives and how wide a range of questions—legal, administrative, ultilitarian, and scholarly—they can answer. The staff of the Cartographic Records Branch invites you to make use of these records. We are at your service.

Aerial Camera Takes Large Area in Short Time

AN AREA THE SIZE OF PENNSYLVANIA could be photographed in less than a day on one very large roll of film with a new aerial camera developed by Perkin-Elmer Corporation for the U. S. Air Force.

To accomplish this the plane would fly at a 40,000-foot altitude. The same job with older apparatus would require a battery of from two to five cameras. The heart of the new camera is a huge 90-pound glass prism that hangs beneath the lens of the camera and rotates in a semicircle, scanning the earth below from the horizon as much as 180 degrees if desired.

The new instrument is called the Transverse Panoramic Camera. It successively photographs strips of terrain below and across the line of flight of the plane, from horizon to horizon. The film used is 18 inches wide and from 200 to 5,000 feet long. If used in a bomber-type plane, the camera could carry a film weighing up to 400 pounds. Each scan of the camera can give a picture 18 inches wide and from 2 to 10 feet long, depending upon the altitude of the aircraft.

The camera is in a fixed position in the plane and does not move. The rotating prism picks up the picture much as a swinging mirror would do. The camera contains no shutter and operates by moving film over a slit, "wiping" an image of the terrain on the sensitized film as the airplane speeds over the ground.

By synchronizing the speed of the film with the ground speed of the plane a perfect picture is secured along the flight path. The instrument scans across the flight path of the plane, depending on successive sweeps of the prism to picture the path. These sweeps overlap to give a continuous scene.

The new camera was developed in cooperation with the Photographic Laboratory of the U. S. Air Force at Wright Field, Dayton, Ohio. Dr. James G. Baker of Harvard University proposed the new design.—*Science News Letter,* March 24, 1951.

Flying Printing Press

A NEW AID to mapping, charting, and psychological warfare is a "flying printing press." It consists of an 8,000-pound package containing an offset printing press with all tools, supplies, and necessary equipment. It was developed for the Armed Forces by the Harris-Seybold Company of Cleveland and Dayton, Ohio. It makes possible on-the-spot reproduction of aerial charts, maps, and reconnaissance photographs and leaflets for psychological warfare. Because timing is important in the use of these, the flying press is expected to furnish the needed speed in their preparation.—*Science News Letter,* May 19, 1951.

An Index of the Horizontal Control in North America

By HOMER C. FULLER

CHIEF, DOMESTIC CONTROL BRANCH, GEODETIC DIVISION, ARMY MAP SERVICE

IN 1947, the Department of the Army adopted a conformal system of military grid coordinates called the Universal Transverse Mercator Grid System for the control of military mapping, the direction of artillery fire, and military surveys. The adoption of this system made the transformation of available horizontal positions, in terms of latitude and longitude or of grid coordinates on local systems, a desirable and necessary objective.

The first phase in the transformation program was the computation of Universal Transverse Mercator coordinates for all stations in the United States.

The magnitude of this operation required mass computing methods and, for this reason, the punched-card electrical calculating machine method was adopted. This made possible the economical and rapid calculation of large quantities of data, and the sorting and listing of the data in convenient form.

This paper deals with the selection and handling of the data and the reasons therefor, rather than with the mass computation procedures used in converting "X" and "Y" coordinates.

PRELIMINARY STEPS

To insure as complete a file of horizontal positions as possible, a circular letter describing the work was forwarded to federal, state, and private organizations known to be engaged in extensive surveying. This letter requested cooperation in the project to the extent of furnishing horizontal positions in terms of latitude and longitude, or of "X" and "Y" coordinates, and the station name. Where "X" and "Y" coordinates were to be furnished on systems other than State Plane Coordinate Systems, information was also requested as to whether the coordinates had an origin common to, or a formula by which they could be converted to, the national system referred to the 1927 North American Datum. By requesting only the station name and position, the need for the establishing agency to compile or reproduce large quantities of descriptive matter was avoided. The position would provide an index to the location of the station; its description, photo-identification, azimuth data, and sketches could be requested later if needed.

In addition to the collection of data by circular letter, the files of the geodetic division of the Army Map Service (which already contained copies of the data of nearly all agencies) were compared with the master files of leading government civilian agencies and brought up to date.

METHODS OF SELECTING AND HANDLING DATA

Before forwarding the horizontal position data for computation of coordinates, a letter and serial number were assigned to each individual station—the letter denoting the agency from whose data the position was obtained, and the serial number providing a means of machine-sorting one or a group of stations.

The letter denoting the agency from whose data the position was obtained is important, because nearly all agencies engaged in surveying publish the posi-

tions of the stations of other agencies which originally controlled their work. Elimination of the resulting duplications by inspection was not economically feasible nor was it desirable.

An Act of Congress, which defines the activities of the Coast and Geodetic Survey, authorizes it to establish the precise basic horizontal and vertical control in the United States, its Territories and possessions. It must, therefore, maintain the precision and adjustment of its surveys in relation to the adopted datum. But in almost all other agencies, surveys are made for an immediate specific use such as the control of a map, the construction of a levee or highway, or the definition of a parcel of land. When these projects are completed, the survey data become a sort of neglected byproduct which may in time fall into a condition where it lacks adjustment to the networks established by the Coast and Geodetic Survey or any other precise piece of work which has been extended in the immediate area. The condition where fairly extensive survey work has been overlapped at a later date by triangulation of the Coast Survey is a common one, and, although that agency makes all reasonable efforts to tie in several of the existing stations, the adjustment of the intermediate or remaining stations might not be undertaken by the agency whose work was established first.

This problem, or condition, might be a fitting one for consideration by the Division on Control Surveys of the Congress. The question to be resolved is whether or not the agency which leaves survey marks on the ground has a moral responsibility to maintain the position results of the survey in as close agreement as possible in relation to the accepted 1927 North American Datum. This may not be applicable to state or municipal agencies, but should be required of all agencies supported by federal funds. As long as the marked stations are present on the ground, some public or private agency will want to use the results. I can recall many times hearing the complaint: "We could not check between these stations!" The uninitiated assume that the work of one agency or another is not accurate.

Since the positions in this tabulated index which we have produced are given as published by the source agency and, in the final steps, were sorted into quadrangles represented by 15 minutes of latitude and longitude, and by ascending latitude within these 15-minute units, the duplicated stations having the same, or nearly the same, position will be found grouped together. Differences of latitude and longitude of stations as published by two or more agencies indicate the extent of agreement between their surveys. These differences also provide a means of correcting the positions of all surveys into agreement with the more precise positions of the Coast and Geodetic Survey as referred to the 1927 North American Datum. The correction of positions in most instances involves a blanket, proportioned, or graphically determined correction sufficient only to bring stations within the position accuracy needed for stereo-photogrammetric mapping. The photogrammetrists' techniques and the precision of their work are constantly improving, and discrepancies between positions of points on unrelated surveys are readily apparent in an oriented stereoscopic model.

The comparison of the positions of duplicated stations to relate various surveys is only one of the uses which can be made of the final tabulated results. The Transverse Mercator Plane Coordinates can be used with mechanical plotting instruments such as the Stereoplanigraph and Coordinatograph or to manually plot the base manuscript and control of any map. Both methods are used at the

Army Map Service. The tabulations provide an easy reference index to one station or a group of stations. The latitude and longitude of a location estimated to the nearest mile from any map—or scaled if an exact identity is desired—will locate the station in the tabulation where the position, designation, and establishing agency can be identified.

As new position data were constantly being received, it was necessary to declare a cut-off date in the processing of material in order that a tabulated result could be run. This date was set at November 1, 1949, and, although over 25,000 new positions have been received since that date, the material has been set aside. From time to time as additional positions become available, grid coordinates will be computed and the stations sorted into the proper sequence in quadrangles. Then sections of the tabulation which are affected will be re-tabulated and dated to indicate the revision.

RESULTS OF THE STUDY

One complete tabulation of horizontal positions, which we refer to as the Tabulation of January, 1950, is complete and a few of the results are as follows:

Positions in terms of "X" and "Y" coordinates, on 40 different systems, transferred to geographic positions	103,308
Positions in latitude and longitude transferred to Universal Transverse Mercator coordinates	729,792

A breakdown by agency of the positions transferred to Mercator coordinates is as follows:

Agency	*Position*
Coast and Geodetic Survey	132,125
U.S. Geological Survey	354,471
Corps of Engineers	79,024
U.S. Army	27,365
International Boundary Commission	25,869
State Geodetic Surveys	43,363
Soil Conservation Service	14,520
Tennessee Valley Authority	20,665
Texas Reclamation Department	3,925
U.S. Forest Service	7,674
Bureau of Reclamation	1,260
City and County Organizations	8,499
Private Organizations	11,032
Total	729,792

The positions of the Coast and Geodetic Survey represent monumented or intersection stations, but the greater portion of the positions of all other agencies are unmarked road intersections, fence corners, centerlines of bridges, and other features which are referred to as picture points.

The completion of this project required 2 years—more than was originally estimated. However, the total number of stations computed was much greater than anticipated. In addition, during the period in which the position data of the United States were being processed, tabulations and computations were completed for 21,307 stations in Alaska, 12,618 stations in Canada, and approximately 25,000 stations needed ahead of schedule for mapping projects. The re-

sults of the work in these areas have been available for some time to properly entitled agencies.

WILL SUPPLY MUCH-NEEDED INDEX

Although the project was approved primarily for the production of military grid coordinates, it will also present an opportunity to compile a pin-point index of the horizontal control stations in the United States. This opportunity had never before presented itself; no agency had ever been called upon to collect such a file of data, nor had an installation of punched-card machinery necessary to handle it. Such an index would provide information through which duplication of costly surveys might be avoided. For example, many agencies have had the experience of initiating survey work and, after work was in progress, found monuments which indicated the area had previously been surveyed. Information on the location of these previous surveys and the availability of the data might have saved thousands of dollars on the cost of a particular project. A pin-point index such as the Army Map Service has compiled will provide this information.

The foregoing statement does not imply that the major survey agencies, such as the Coast and Geodetic Survey and the U. S. Geological Survey, do not index their control or make such information available to the public; these agencies maintain adequate diagrams and indexes which reference the locations of their surveys. However, the average private agency is not aware of the many other highly valuable pieces of work which have been extended by the Tennessee Valley Authority, the Forest Service, the Soil Conservation Service, the State Geodetic Surveys (which operated in the thirties as Federal Works Projects), approximately 50 civilian installations of the Corps of Engineers, Army Topographic Units, and many private, state, and municipal organizations.

The primary purpose of the geodetic data of the Army Map Service is to supply requests of the Department of Defense, but the regulations also state that it will cooperate in the exchange of data with government and civilian agencies. Sections of the final tabulation of positions will be supplied to civilian agencies but the descriptive matter, azimuth data, sketches, or other details, should be requested from the establishing agency, which can be identified by the letter accompanying the serial number of the station on the tabulation.

Information requested on certain stations coded by letters which do not clearly define the establishing agency will be supplied, or channeled to the correct agency, by the Army Map Service.

An opportunity to cooperate in the maintenance of an index of horizontal positions is one which requires only a small expenditure of time, and the cooperation required from other agencies is only the supply of the station name and its position. Organizations or individuals wishing to cooperate should forward their information to the Commanding Officer, Army Map Service, Washington 16, D. C., Attention: Geodetic Division.

* * *

"SIX-PLACE TABLES"

THIS seventh edition of a handy reference work for engineers contains tables of squares, cubes, square roots, fifth roots and powers, circumferences and areas of circles, common logarithms of numbers and trigonometric functions, natural logarithms, exponential and hyperbolic functions, and integrals. It is published by the McGraw-Hill Book Company, Inc., and costs $2.50.—*The Military Engineer*, May–June 1951.

Organization of Surveys, Mapping and Charting in Canada

By W. H. MILLER

DIRECTOR, SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS

BROADLY, the Surveys and Mapping Branch is responsible for the provision of geodetic control, topographical maps, aeronautical charts, hydrographic charts, and for the subdivision and legal survey of federally controlled lands throughout Canada. It is one of five branches of the Department of Mines and Technical Surveys, the others being the Geological Survey, the Mines Branch, the Geographical Branch, and the Dominion Observatories.

The Minister of Mines and Technical Surveys is the head of the department and is responsible for policy. Like the other Cabinet Ministers, he is an elected member of Parliament, appointed to the Cabinet by the Prime Minister. The Deputy Minister, who is responsible for carrying out the policy, is a permanent civil servant, as is the Director-General of Scientific Services who has over-all charge of the scientific activities of the five branches. Each branch, in turn, is headed by a director.

The Surveys and Mapping Branch has five divisions, namely: the Geodetic Survey, under the Dominion Geodesist; the Hydrographic Service, under the Dominion Hydrographer; the Legal Surveys and Aeronautical Charts Division, under the Surveyor General; the Topographical Survey, under the Chief Topographical Engineer; and the Map Compilation and Reproduction Division, under the Chief Cartographer. Each division has special functions which, combined, produce the maps and charts, and provide survey control necessary for the development and administration of the country.

Before discussing the activities of each division of the branch, an account of some of our special problems will provide a background for those not familiar with the Canadian picture.

The most outstanding of these arises from the fact that we have a country of over 3½ million square miles, which is rich in developed and undeveloped natural resources, but a population of less than 14 million. This makes it imperative that every effort be made to avoid duplication of services. Under the circumstances, cooperation among the various Government agencies, both Federal and Provincial, is essential, and we like to feel that in Canada this cooperation has reached a high degree of efficiency.

Also, the settled and developed part of our country is a comparatively narrow band along our southern boundary, and because of climatic conditions our field work is confined to about 4 or 5 months of the year. To these are added the difficulties encountered in the matter of transportation and supply in large areas of the country without roads or railways. Since we cannot have a field force continuously engaged in procuring field control, we must allot the use of special equipment such as aeroplanes equipped for photography, helicopters, and the like in such a manner as to effect a maximum of field work during the short season with the funds made available by Parliament.

GEODETIC SURVEY

The Geodetic Survey provides a national system of leveling and precise triangulation surveys for use as geodetic control by federal and provincial departments, and private agencies. It provides a control for international and interprovincial boundaries and data on horizontal and vertical movements of the earth's crust. It also provides astronomic control for small-scale mapping in areas where more accurate control is not available, such as for air charts in the North. The Dominion Geodesist is Canada's representative on the International Boundary Commission.

HYDROGRAPHIC SERVICE

The Canadian Hydrographic Service produces and distributes Canadian aids to navigation, such as hydrographic charts; volumes of "Pilots and Sailing Directions" covering coastal and inland waters; standard tidal publications; and "Water Level Bulletins" for the St. Lawrence and Great Lakes waterways. A regional hydrographic office at Victoria, B. C., supervises charting and tidal operations, and distributes hydrographic publications for the Pacific coast. In the production of charts the Hydrographic Service compiles the results of its surveys and prepares the fair-drawn material for reproduction. After printing, the charts are returned for distribution so that a close check can be kept to see that only the material with the latest information is sent out.

TOPOGRAPHICAL SURVEY

The Topographical Survey is responsible for original mapping at scales of 4 miles to 1 inch or larger. It does the field work necessary to provide horizontal and vertical control for mapping by use of air photographs and completes the resultant map manuscripts to the stage of final drafting. It also includes the National Air Photographic Library which is responsible for indexing, preserving, and distributing prints from all air photography done by or for the Federal Government. At present 2,025,000 prints are on record in the Library as well as full information on all air photography in Canada carried out by provincial governments and commercial companies, all of which deposit prints although there is no compulsion for them to do so. The prints are available for inspection and study by the public, and all orders for prints from negatives held by the Government are placed through the Library.

LEGAL SURVEYS AND AERONAUTICAL CHARTS

The Legal Surveys and Aeronautical Charts Division is responsible for all land subdivision work on Federal lands and for the production of aeronautical charts. Federal lands comprise Yukon, Northwest Territories, national parks, and Indian reserves. Each province has control of its own lands and requires that its own registered land surveyors carry out land surveys within its boundaries. The base for the aeronautical charts is produced by the Map Compilation and Reproduction Division, but the Legal Surveys Division is responsible for plotting base information from trimetrogon photography when necessary. This work is designed to be reproduced at a scale of 8 or 16 miles to 1 inch and is controlled by astronomic fixes made by the Geodetic Survey. The distribution of maps produced by the units of the Branch comes under the Legal Surveys Division.

MAP COMPILATION AND REPRODUCTION

The Map Compilation and Reproduction Division compiles all maps other than those made from original surveys. It does the fair-drawing on all sheets produced by the Topographical Survey and the Legal Surveys and Aeronautical Charts Division, and all the photographic and lithographic work for the Branch, with the exception of the standard 1- and 4-mile sheets of the Topographical Survey, which are reproduced by the Army Survey Establishment from the drawings made in the Map Compilation and Reproduction Division.

COOPERATION WITH OTHER AGENCIES

I have dealt only with the Surveys and Mapping Branch of the Department of Mines and Technical Surveys. There is also the Army Survey Establishment which is the Mapping Branch of the Department of National Defense. This unit is fully organized for mapping, from the making of field surveys to the production of the finished map. The relations of our two organizations are an excellent example of cooperative work of which we are justly proud. The mapping requirements are considered as a whole and programs are laid out jointly. During the field season these parties work under the administration of the Surveys and Mapping Branch, each Department contributing its share of the costs. The reproduction and printing of the resultant maps are done by the Army Survey Establishment at a cost to our Department only of the materials used.

Although the Federal Government organizations work throughout the country, some of the provinces have their own mapping units to meet their own particular needs. Duplication of effort is avoided by means of frequent consultations with provincial authorities.

Two other items should be considered in connection with our survey organization, namely, the provision of air photographs, and survey research.

Aerial Photographs

The provision of air photographs is handled through the Interdepartmental Committee on Air Surveys. This committee with its sub-committee is made up of representatives from all federal departments using or helping to provide air photographs. All requirements are submitted to the committee which decides on the priorities of areas to be photographed and the scales of photography. It also lets any necessary contracts and arranges for carrying out the work either by the R.C.A.F. or commercial companies. The work, except that done by the Air Force for the Department of National Defense to which it belongs, is paid for by the Department of Mines and Technical Surveys.

Survey Research

Federal Government research work on surveying, as soon as it reaches beyond the requirements or facilities of one particular unit, is handled by the "Associate Committee on Survey Research" established by the National Research Council. On this Committee are representatives of the Research Council, the Army Survey Establishment, the R.C.A.F., the Defense Research Board, and the Department of Mines and Technical Surveys. Particular problems are handled by sub-committees appointed by the Associate Committee. Members of the sub-committees are chosen from within or without the government service, the primary requisite

being their knowledge of, or interest in, the problem with which they are dealing. Their activities are supported by all departments interested and are financed by the Research Council or by interested departments. Often a whole project may be worked out cooperatively by the departments concerned, each contributing what it has available in the way of equipment, facilities, or knowledge.

There you have the picture of our organization and of how it functions. We are constantly studying new techniques and equipment and adopting them where desirable. Though each has its separate responsibilities, the various units of our Branch work cooperatively toward the common end of providing the best in mapping, charting, and surveying services to aid in furthering the study of Canada's natural resources and the development of the Canadian economy as a whole.

Radar Rule

RADAR waves, bombarding a rare form of atomically produced mercury may be used to produce a new international yardstick that will never change or be lost. This is a project on which two Pittsburgh scientists, Kenneth B. Adams, of the research laboratories of Westinghouse Electric Corporation, and Dr. Kevin Burns, astronomer at the Allegheny Observatory, are working. They hope to help perfect a super-accurate standard on which all international measurements of length can be based. Scientists in France and England are working on the same project.

It won't be the kind of yardstick one can pick up, because it will be calculated from the wave length of light waves emitted from the bombarded mercury. But it will be accurate, the scientists say, to 1 part in 40 million.

The mercury is artificially made from gold at the Oak Ridge, Tenn., atomic pile. The experimental process, as explained by Mr. Adams, is as follows:

"We take a microscopically small quantity of mercury—perhaps only 1/25,000th of an ounce—and place it in a capsule with argon gas. Then we bombard it with ultrashort waves like those used in radar.

"The radar bombardment causes the mercury vapor to glow, sending out a very bright light. By means of a spectrograph and a special device called an interferometer, this light is broken up into various wave lengths and recorded on a photographic plate in a series of many concentric circles.

"By measuring the diameter of the circles and then doing some very complex mathematical calculations, we can determine the number of light waves of mercury in an inch, a foot, or a yard."

Before the new yardstick (actually a meter of 39.37 inches) can be accepted internationally, its measurements must be confirmed by at least three laboratories in different parts of the world.

The present international standard is the number of wave lengths of red light emitted in a similar way from the element cadmium.

"Although cadmium has an accuracy of 1 part in 10 million," Mr. Adams said, "the special form of mercury we are studying can improve this accuracy to 1 part in 40 million."—*Marine News*, November 1950.

Topographic Map Revision and Maintenance

By J. E. KING

CHIEF, AERIAL PHOTOGRAPHY AND MAPPING, U. S. FOREST SERVICE

IT GIVES me considerable pleasure to have this opportunity of expressing my views on topographic map revision and maintenance. For quite some time, this phase of mapping has been of utmost interest to me as a map maker as well as in my official dealings with map users.

Map revision in the past has been more or less an orphan, or at least a stepchild, of map construction. Undoubtedly there are many justifications for such condition. The prime reason, probably, is our enthusiasm to cover as much of the country as possible with new maps, hesitating to revise old maps while there remain such vast areas lacking adequate topographic maps. Moreover, there seldom existed in the past topographic bases sufficiently accurate to warrant correct revision. This, of course, meant the necessity of remapping an area, which was rarely, if ever, justified. However, conditions have rapidly changed, and with the topographic mapping procedures now used in the construction of standard maps, revision and maintenance become a relatively simple and inexpensive process when compared to original map construction.

It is vitally important that revision and maintenance be conducted hand-in-hand with map construction. In making this statement, I realize many people may disagree with me. To me a topographic map is a working tool furnished public administrators, engineers, scientists, and the general public for utilization to their best interests, serving not *one* but *many* purposes. An out-of-date map immediately loses its usefulness. Our National Mapping Program may be compared with our vast highway system. We would not think of building highways without a systematic and economical means of maintaining the system. Likewise, we should not construct more maps than can be incorporated in a systematic revision and maintenance program unless the first cost of these maps can be written off as a project need and then forgotten.

PRACTICABILITY OF PHOTOGRAMMETRIC REVISION SHOWN

Too often we find that a map user has discarded a good topographic map for a less accurate planimetric map simply because the detail of the latter is up to date. I recall an incident in the western part of the United States where a Government agency flatly refused to use U. S. Geological Survey topographic maps which encompass an area of nearly 500 square miles. The reason given was that the features on the map could not be reconciled with those on the ground, and consequently it was imperative that a planimetric map be made as an immediate substitute. These topographic maps were dated in the early 30's and had been prepared without the use of aerial photography.

This particular incident interested me personally, and I induced the agency to permit the Forest Service to make a photogrammetric revision of the existing topographic map rather than to construct an independent planimetric map of the same area. This job was quite revealing to the agency involved, as it showed that contours were most precise in shape and position with, of course, the small discrepancies in the meandering of insignificant streams that would normally be expected to exist between a planetable and photogrammetric survey. In few

cases, if any, were these discrepancies of sufficient consequence to render the map valueless. However, the planimetry was a different story and the findings verified the agency's statements. During the 20-year lapse of time, old roads had been abandoned, new roads built and alignments changed, new cuts and fills made, trails abandoned, new trails added, small reservoirs built, and lakes created. All this contributed to a change in the facial expression of this otherwise good topographic map to the extent that the average map user would discard it as a worthless article. In the topographic revision process, it was only necessary to revise the contours or topographic expression in those few small places where man or nature had changed the configuration of the earth's surface. Upon completion, the map was accepted as a *super-duper*, up-to-date topographic map made at a cost approximately the same as that required for the temporary planimetric map. Furthermore, the cost per square mile was $80 to $100 less for this map than for an original topographic survey.

This example is given to illustrate the condition existing throughout the entire continental United States. This is a condition in which not only the map users should be interested but the map maker, as well. The map-making agency should view it with considerable concern and alarm, for it is the product that is being condemned, not through faulty workmanship but through the total lack of adequate maintenance of the product. When this occurs the mapping agency acquires the reputation in the eyes of the map users of producing an inferior map or one which is not usable for their particular needs.

SYSTEMATIC REVISION PROGRAM NEEDED

We now have the greatest opportunity in the history of map making to inaugurate an economical and systematic map-revision program with our present-day, high-accuracy topographic-mapping methods. This is particularly true with the uniform use of photogrammetry throughout the Federal Government and in private industry. The revision and maintenance of maps is principally planimetric in character and should occur at necessary intervals, which depend upon economic factors affecting the area involved.

Equipment and procedures required in map revision should be considerably different from those utilized in original map construction. The expensive type of equipment needed for map construction is not necessary in revision work. Personnel involved in revision work should be highly trained. Experience has shown quite conclusively that photogrammetrists or topographic engineers who are excellent in the construction of new topographic maps are often not efficient on map revision work which requires a different temperament different type of equipment, and an entirely different approach. For maximum efficiency, map revision and maintenance should be separated entirely from map construction.

In conclusion, it is my conscientious belief that in order to protect the investment in the original topographic maps, a systematic program along the following lines should be seriously considered.

1. Whenever any topographic map is constructed, the agency should determine the life of the culture of the map from the best information available, and furnish such data to a review board responsible for evaluating the obsolescence of all topographic maps in order to establish revision dates.

2. To obtain a balanced program, close comparisons should be made between costs of constructing new topographic maps and revising the same maps. The results of this com-

parison should determine the criteria for the disbursement of funds for map revision and maintenance.

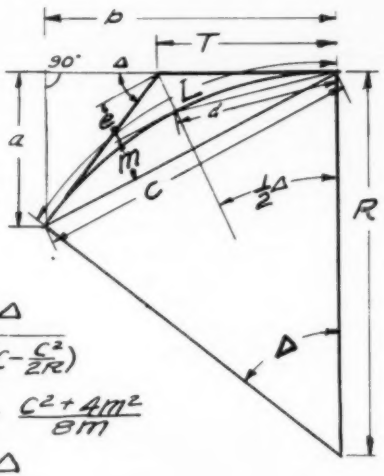
3. Concentrated effort should be made to see that no topographic map becomes out of date, even though new mapping would be curtailed.

* * *

Circular Curve Formulas

By CLINTON C. HUBBELL

CIVIL ENGINEER AND SURVEYOR, NORWALK, CONN.



$C = 2R\sin \tfrac{1}{2}\Delta$

$C = 2T\cos \tfrac{1}{2}\Delta$

$C = \sqrt{2Ra} = \sqrt{a^2+b^2}$

$c = 2\sqrt{m(2R-m)}$

$e = R\,\mathrm{exsec}\ \tfrac{1}{2}\Delta$

$e = R\tan \tfrac{1}{2}\Delta \tan \tfrac{1}{4}\Delta$

$b = R\sin\Delta = a\cot \tfrac{1}{2}\Delta$

$b = \sqrt{a(2R-a)} = \sqrt{(c+\frac{c^2}{2R})(c-\frac{c^2}{2R})}$

$R = \frac{a^2+b^2}{2a} = \frac{c^2}{2a} = \frac{d^2}{2m} = \frac{c^2+4m^2}{8m}$

$d = \sqrt{2Rm} = 2R\sin \tfrac{1}{4}\Delta$

$m = R\ \mathrm{Vers}\ \tfrac{1}{2}\Delta$

$m = \frac{d^2}{2R} = R \mp \sqrt{(R+\frac{c}{2})(R-\frac{c}{2})}$

$m = R\sin \tfrac{1}{2}\Delta \tan \tfrac{1}{4}\Delta = \tfrac{1}{2}c\tan \tfrac{1}{2}\Delta$

$a = R\,\mathrm{versine}\ \Delta - b\tan \tfrac{1}{2}\Delta$

$a = T\sin\Delta = R\sin\Delta\tan \tfrac{1}{2}\Delta$

$T = R\tan \tfrac{1}{2}\Delta$

$\Delta = \frac{L}{R} \times 57.29578^\circ \qquad R = \frac{L}{\Delta}\,57.29578$

AREA OF FILLET $= R^2(\tan \tfrac{1}{2}\Delta - \mathrm{LCA}\,\tfrac{1}{2}\Delta)$

AREA OF SEGMENT $= \frac{R^2}{2}(\mathrm{LCA}\,\Delta - \sin\Delta)$

Establishing Control for Aerial Mapping Test Area in Southern Arizona

By PAGE F. HOPKINS

MADDOX AND HOPKINS, SILVER SPRING, MARYLAND

IN the establishment of an aerial photographic and camera test area in southern Arizona, for the Army Map Service, several very unusual circumstances were encountered. The area surveyed embraced four 15′ quadrangles with approximately one-third lying in the Salt River Irrigation District, the remainder in the desert and mountains.

As this was to be a test area, the Army Map Service requested the establishment of horizontal control on picture points over two-thirds of the project at 1-mile intervals, and on the remainder at 2-mile intervals. Vertical control was established on picture points at 1-mile intervals over the entire project.

TRIANGULATION

In the establishment of basic triangulation control, stations were located in the field as near as practicable to the corners of a 6-mile grid, and were then interconnected by traverse. Because of the terrific heat, night triangulation was necessary. Several novel systems of signal and recognition lights were used. In the urban area of the project the key Coast and Geodetic Survey first-order control points consisted of two mountain stations and a station atop the courthouse in the city of Phoenix. For observing from the ground, automatic lights were obtained from the Scott Technical Instrument Company of Phoenix.

For use on the mountain stations these lights were revolved by wind cups and controlled by a 10-day clock. Four No. 6 dry cell batteries powered the light 4 hours a night for approximately 10 days. They provided a blinking signal at about 1-second intervals under normal wind conditions. The lights were easy to identify and the clock mechanism eliminated the necessity for light tenders at the stations. They were not, however, satisfactory for the courthouse station because of wind obstructions.

After a careful survey of the city skyline at night it was decided that a white light on the courthouse would be almost impossible to identify. Since there was no other green light in the area a 5-foot green vapor tube was selected and mounted on a rod carefully plumbed over the station. The tube proved to be an ideal sight as it was visible to the naked eye up to 10 miles, yet small enough to hide behind the vertical hair of the theodolite. On the ground stations, red railroad flares were used as recognition signals. They were visible to the naked eye up to 20 miles and very easy to identify among the lights of the urban areas.

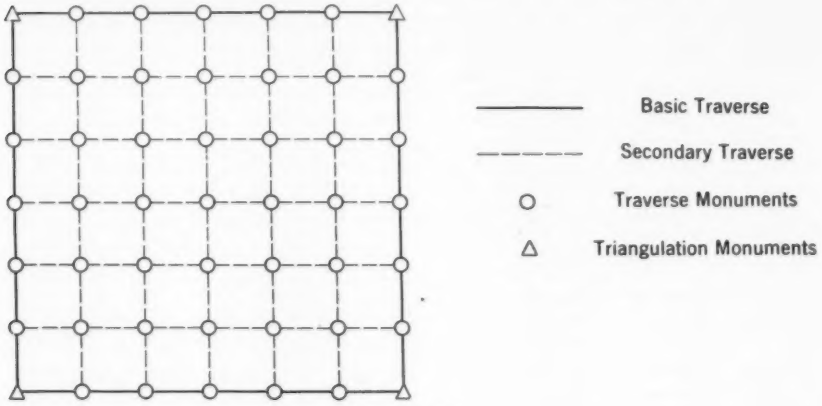
TRAVERSE LINES

The horizontal control was established on a grid pattern as all single traverse lines were limited by the specifications to a maximum of 8 miles; basic triangulation stations were established at 6-mile intervals and then inter-connected by basic traverse. These lines were adjusted between stations and secondary lines run at 1-mile intervals through the squares.

All traverse was specified as third-order, but extreme care was necessary in running the basic lines in order to insure adequate closures. Analysis of the

accompanying figure will show quickly that trying to connect third-order traverse between adjusted third-order positions at 6-mile intervals poses quite a problem. We found that holding the traverse angles to an adjustment of 3″ or less gave us tight enough azimuths in our basic lines to insure closures of the secondary traverse of third-order accuracy, or better.

Chaining on all traverse was done carefully, but without the use of chaining stools. Temperature and tape corrections were applied and very little traverse had to be re-run. Our greatest trouble was in the dropping of a chain length. The lines were too long to use stadia as a check, and several other methods such as chaining arrows were tried, but the most effective was for each chainman to use a notebook and when the recordings failed to check at the end of the line, the line was rechained then and there.



LEVELING

Vertical control was carried forward from existing first- and second-order Coast and Geodetic Survey monuments by running levels of third-order over all basic traverse and triangulation stations. The length of line was, under the specifications, not to exceed 15 miles and this necessitated running some second-order levels in order to bring control into position. A K. & E. dumpy level was used on most of the project. Of the approximately 1,200 miles of levels run, less than 20 were run over.

The basic third-order lines were interconnected with fourth-order levels over the secondary traverse. Planetable levels using a Beaman arc for reducing the vertical angles were used in some instances with very good results. Fourth-order levels were established in the mountains by vertical reciprocal levels observed with optical-reading theodolites. A minimum of two sets of direct and reversed angles were observed which would check within 5″.

PICTURE POINT CONTROL

Picture points at places other than stations in the traverse were tied in at the time the traverse was run by turning the angle from the traverse station in each direction, and checking these two angles against the traverse angle at the station. The distances were chained forward and back and then checked by

stadia to guard against blunders in the determination of the horizontal positions of the picture points.

In the mountainous areas, and one portion of the project where the horizontal control was at 2-mile intervals, all picture points were established by triangulation. The figures were controlled to the desired third-order accuracy by holding the angle at the station being established to between 30° and 150° and holding the leg lengths to a maximum of 12 miles.

MONUMENTATION

Monumentation on such a large scale became quite a problem. To expedite the setting of the standard bronze survey markers, mechanized equipment was essential. After securing permission from the State highway, county, and municipal engineers and from the Salt River water users to set the markers in headwalls and other permanent structures in the populated areas, a two-man crew, equipped with an Ingersol Rand J-10 jack hammer and a 20-cubic-foot air compressor, was sent out. This rig proved ideal since it was light enough not to damage installations such as bridge curbs and irrigation gates, yet could drill a 1-inch hole 4 inches in depth and countersink the plate in approximately 3 minutes. As many as 30 survey caps were set in 1 day.

In the desert areas, and other places where no suitable permanent structures existed, a precast concrete monument 6 inches in diameter and 42 inches long was used. To set these monuments, a jeep-powered post-hole digger was used, drilling a 9-inch hole 42 inches in depth in approximately 2 minutes, under normal circumstances. Considerable difficulty was encountered with the digger as it was originally equipped with cast-iron ring and pinion gears which could not stand the hard digging encountered. These were replaced, however, by chrome alloy steel gears from the differential of a wrecked midget racing car. The original suspension was from the draw bar at the rear of the jeep. As the weight of the rig was concentrated approximately 5 feet beyond the center of the rear wheels, tending to raise the front and causing the rear to dig into the desert sands, an "A" frame was built just behind the driver's seat and the suspension raised to the bottom of the tailgate, allowing the whole rig to be swung inboard while traveling.

As it was impracticable to tow a trailer while carrying the post-hole digger (it would have had to be uncoupled each time a hole was drilled), the precast monuments were stock piled in convenient areas. Very careful planning was required to lay out the routes for maximum efficiency in this operation.

PANELS FOR PICTURE POINTS

Because of the lack of natural picture points in the desert area, the Army Map Service decided to construct panel markers of a semi-permanent nature. A cross with four arms each 20 feet long and 8 feet wide, meeting in an open center, was used. The panels forming the cross were centered on the survey monument and constructed of stabilized soil. After the area was cleared and leveled 1- by 3-inch forms were set in place, the tops being flush with the surface of the ground. The natural material within the forms was loosened and straight-edged and 0.85 gallon of SC-1 cut-back asphalt was applied under approximately 40 pounds pressure to insure a 2-inch penetration. After allowing this to set for approximately 96 hours, 0.50 gallon of water-base emulsion was applied. This was

used because it would not penetrate and after drying left a smooth, glazed surface which was ideal for photographic purposes.

Because of the lack of roads, it was necessary to use 4-wheel drive vehicles to move the equipment used in laying the panels. A 2-inch rotary pump, driven by a power take-off, was installed on the rear of a jeep to spray the asphalt. A light trailer carrying three 55-gallon drums was used to transport the material.

In the mountainous areas picture panel points were laid out to give a horizontal projection of 40 feet. Because of the steep terrain some were over 70 feet in slope measurement. They were built of rock 8 inches or more in diameter, with the voids filled by smaller pieces to preclude any shadows. They were painted with a white, plastic-type paint guaranteed for 3 years by the manufacturer.

To summarize, the total work involved the establishment of approximately 150 triangulation stations, 800 miles of traverse, and 1,100 miles of levels. All horizontal control was of third-order accuracy, with vertical control of third- and fourth-order accuracy.

* * *

General Study for Engineering Students Recommended

A PROGRAM of general studies for college engineering students "to develop a sense of highest social responsibility" was proposed at a recent regional convention of the American Society for Engineering Education at Lehigh University. William A. Aiken, professor of history at Lehigh, serving as moderator of the panel discussion, said, "Higher education should first of all seek to encourage intelligent criticism and evaluation of past and current religious, philosophical, social, economic, and scientific theories and doctrines in order to develop a sense of social responsibility in each individual for the welfare of his neighbor and mankind as a whole. In general, engineering education has found its loyalties divided until specialization and narrow professional interests have led to a shirking of more fundamental issues."

Aiken proposed a program of general studies for the engineer. In the freshman year, man would be studied as a purely physical being; two courses would be required, one in human biology for the first semester, and another in principles and problems of psychology for the second semester.

"The sophomore year would stress man's responsibilities as a social being, with required courses in cultural anthropology and economics, one each semester."

In the third year, all engineering students would examine the story of man as a civilized being; a single course would be required both semesters in the development of Western civilization.

"The senior year would be open to 3 hours each semester of elective courses in carefully chosen fields, such as religion, philosophy, the fine arts, literature, histories of scientific or economic thought, labor problems, sociology, botany, paleontology and astronomy. Excluded from senior electives would be all such courses as serve exclusively a utilitarian function."—*Engineering News-Record*, June 22, 1950.

Numbers to the Ancient Greeks

By FORREST DANIELL
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THE SCIENCE OF SURVEYING depends to a large degree upon mathematics, which has its foundation in arithmetic. The Greek word "arithmos" means *number* while the word "arithmetica" means *the theory of numbers.*

According to ancient manuscripts, the life of man, composed of vain hopes and groundless fears, found expression in a mysticism which included numerology with its omens and superstitions. The mystical meaning and divine virtue of numbers formed a major part of the philosophy of Pythagoras, a Greek geometrician who lived in the sixth century, B. C. Pythagoras founded a philosophical society in Italy which bound its disciples to a strict training in gymnastics, mathematics, and music, and taught *numbers* as the science which determined the proportions of architecture, the harmonies of music, and the movements of the sun, moon, and stars. Pythagoras has been regarded as the real founder of the science of geometry.

In *numbers,* Pythagoras saw the principle of all things. His doctrine was that *numbers* are of two kinds—intellectual and scientific. The *intellectual number,* which has always existed in the divine mind, is the basis of universal order, and the link which binds all things. The *scientific number* is the generative cause of multiplicity which proceeds from and is the result of unity.

Scientific numbers were considered to be either even or odd. Even numbers were known to be female as they admitted of division, or generation, and odd numbers were known to be male. However, odd numbers were considered to be the more nearly perfect.

Pythagoras and his followers, who had a great influence upon subsequent speculative thought, ascribed a peculiar character and quality to each number.

One represented God, without beginning and without end, the point within the circle. Because it is indivisible, it also denoted friendship, love, and piety. *One* was the symbol of identity, equality, existence, and universal preservation.

Two was considered unlucky. While *One* denoted light and the food principle or God, *Two* denoted darkness and the evil principle.

Three was considered the chief of the mystical numbers as it contains within itself a beginning, a middle, and an end. This number referred to harmony, friendship, and peace.

Four was considered a divine number; it referred to the Deity, and among the ancients many nations gave to God a name of four letters. It also stood for justice, because it is the first perfect square, the product of equals.

Five denoted light, nature, and marriage. In marriage, the female *Two* and the male *Three* were united.

Six was considered a symbol of justice, because it was the first perfect number, that is, one whose aliquot parts added together make itself. The aliquot parts of six, which are one, two and three, are equal to six. This number was also an emblem of health.

Seven was called a venerable number and was highly esteemed, since this number referred to the creation of the world. The Pythagoreans said that this number was made from two perfect figures, the triangle and the square.

Eight signified friendship, prudence, counsel, and justice, and was greatly esteemed as it was the first cube ($2 \times 2 \times 2$). It designated the primitive law of nature which supposes all men to be equal.

Nine was called a perfect or finished number, because 9 months is the period required for the perfection of a human being before birth. The Pythagoreans, finding that this number has the power of always reproducing itself by multiplication (as for an example $2 \times 9 = 18$, and 1 and 8 equal 9; likewise, 3×9 equals 27, and 2 and 7 are 9, etc.), considered it the emblem of matter, which, though continually changing its form, is never annihilated. The number *Nine* was likewise sacred to the circle since the circumference of a circle is 360 degrees, and 3 and 6 and 0 are equal to 9.

Ten denoted Heaven because it was the consummation and perfection of all things, and was constituted by the union of 1, 2, 3, and 4 which add up to 10.

As Jules Henri Poincaré, the great French scientist, has said: "Though the source be obscure, Still the stream flows on."

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New Radar Accuracy

A RECENT DISCOVERY, which at first sight appears to be of theoretical rather than practical value, is likely to have important results in the fields of radar, radio, atomic research, and astronomy. This discovery is a correction to the accepted figure for the speed of light.

The first figure for the speed of light was obtained by Romer in 1676, and various corrections to it were made until 1935, when Michelson obtained the figure of 186,271 miles per second. This speed was confirmed in other experiments and has been the accepted standard for the past 15 years. The equipment used to obtain this standard consisted of a metal tube a mile long through which a beam of light traveled.

During the war Dr. L. Essen, of Great Britain, came to question this speed, and, as it was generally assumed that radio waves and light waves differ only in wave length and not in speed, he decided to check the value by using radio waves in a metal tube 7 inches long. A radio wave traveling down this tube is reflected backward and forward between the two ends; and, when the time of travel between the ends equals the time interval between successive waves, an electrical resonance is produced which can be detected with very high precision.

An idea of the degree of accuracy required for the experiment can be obtained from the fact that the time of travel of the wave between the two ends of the tube is approximately one ten-thousand-millionth of a second. This frequency had to be measured with an accuracy better than one in a million.

The new figure obtained by Dr. Essen was first announced in 1947. He has subsequently confirmed the result, and figures obtained in Sweden and the United States agree to within 1 kilometer a second. The new figure is given as 186,282 miles per second.

Since the whole basis of radar depends upon measuring the time taken by a pulse of radio waves to travel to the target and back, this new figure will increase the accuracy of radar and prove particularly valuable in the use of radar for aerial survey work.—*The Aeroplane*, November 17, 1950.

Portable Lookout Mapping Tower

By KENNETH J. SEIGWORTH

DEPARTMENT OF FORESTRY RELATIONS, TENNESSEE VALLEY AUTHORITY

A PORTABLE, 60-foot, steel, lookout mapping tower has been designed by the Department of Forestry Relations of the Tennessee Valley Authority, and since the spring of 1942 has been successfully used in the visible-area mapping of 13 points in the Tennessee Valley.

The tower is built up of six triangular sections which are 10 feet long and 13 inches on a side. The vertical sections are composed of three steel "U" angles, weighing 1.18 pounds per foot, cross braced at approximately 2-foot intervals by double bars about 1 inch wide by ¼-inch thick and fastened to the angles by cap screws. The vertical sections are joined by lapping and bolting the "U" angles. The tower is attached to, and erected on, a triangular steel base plate by two angle connections on each of the three corner legs. A circular wood platform with guard rail is built around the top section. Total weight of the tower and erection equipment is about 800 pounds. The heaviest individual pieces are the 10-foot vertical sections, which weigh about 75 pounds each.

The cost of the tower, exclusive of platform, erecting, ropes, and tools, was $170. The erection equipment and platform cost about $50.

The tower and erection equipment are readily portable in a ¾-ton pick-up or ½-ton sedan delivery.

Since 1938 the TVA has worked with the state forestry divisions in Tennessee, Alabama, Mississippi, Virginia, and Georgia in developing detection systems and in evaluating existing or proposed tower sites. Altogether 103 points have been mapped. The problem of getting above the trees was a major one at almost every prospective tower site. Prior to availability of the mapping tower, the only solution lay in climbing trees—a time-consuming, exasperating, and generally unsatisfactory arrangement. Mapping was confined to a relatively short period in the early spring after the weather had warmed but before emergence of foliage. It was usually necessary to climb from 2 to 10 trees surrounding the point. In only rare instances were limbs in the right places for satisfactory mapping. There was considerable variation in elevations at which the mapping was done; in all instances where the high point was not a sharply defined peak (and this is usually the case on the Tennessee Valley ridges), it was necessary to map from at least one tree some distance from the point.

The problem of providing a readily portable, reasonably rigid tower high enough to place the mapper's line of sight above most trees was presented to 11 tower fabricators. The suggested designs were too heavy and too expensive in all instances. It proved possible, however, to adapt the design of a radio tower manufactured by the Wincharger Corporation of Sioux City, Iowa.

The platform and guard rail were fabricated by members of the TVA after arrival of the tower. No difficulty was experienced in assembly. Considerable time was required to develop satisfactory erection and lowering procedures for a minimum number of men. These procedures have been developed and recorded in detail.

Reprinted through the courtesy of the *Journal of Forestry*.

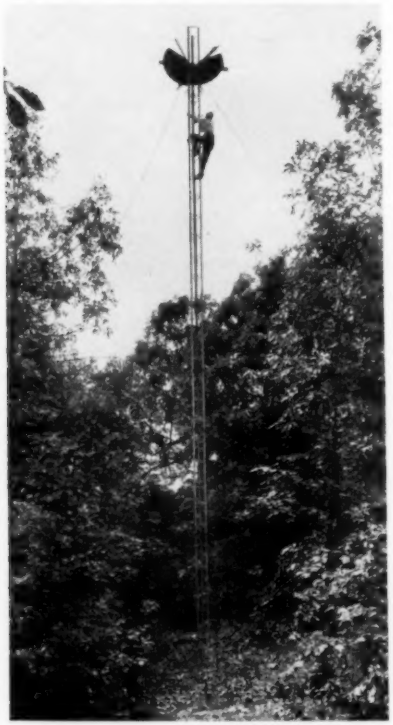
The tower is assembled on the ground on a horizontal plane. It is raised or lowered by means of a "hand crab" (winch) and ¼-inch steel cable running from the winch through a pulley secured about 30 feet above ground and fastened to the tower about 5 feet below the mapping platform. Care *must* be exercised to keep from twisting or bending the tower in the erection or lowering process. Four men are required—one on the winch and three on guy lines.

The mapper climbs the tower after erection and secures himself to the tower with a lineman's safety belt while mapping. The top of the tower is just high enough above the platform to constitute a support for the mapping board. One experienced man and three inexperienced helpers can assemble and erect or lower and disassemble the tower in 3 to 4 hours.

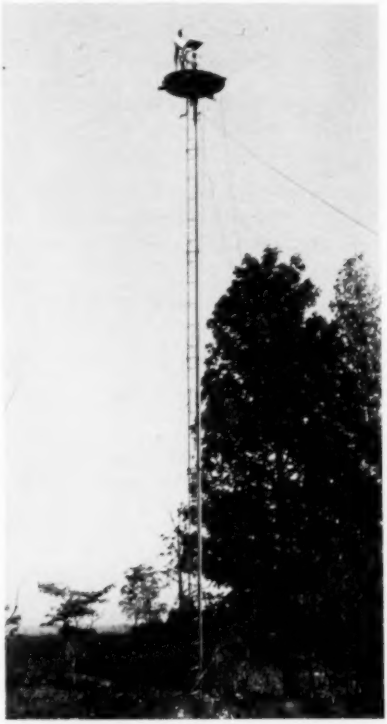
The tower can be erected in any kind of weather. It may be left standing until a quiet and haze-free day occurs. It withstood one storm of cyclone force.

Mapping a given point usually requires about 4 hours. Mapping is difficult on cold or windy days.

This tower has already more than paid for itself in convenience and accuracy of visible-area mapping. It has also been used by the Tennessee Division of



ERECTED TOWER READY FOR MAPPING



TOWER WITH SECTION REMOVED

Forestry as a temporary lookout near a vital war plant pending arrival and construction of a regular lookout tower.

Pictures, use directions, safety precautions, and lists of desirable erection equipment are available to interested forestry agencies upon request.

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Mapping Bedrock Structure by Electronics

(Condensed from a joint release of the U. S. Geological Survey and the City of Chicago)

A NEW TECHNIQUE, involving sonar depth finding, has been successfully applied recently to the problem of tracing the depth of bedrock along Chicago's lake front.

The City of Chicago is planning construction of a new filtration plant and distribution system to provide an additional supply of potable water from Lake Michigan. It was important to know beforehand the configuration of bedrock along the route of a proposed distribution tunnel, 16 feet in diameter, which will run for more than 5 miles underneath the harbor paralleling the water front. The tunnel will be constructed about 50 feet below the top of the limestone bedrock to prevent contamination of the water after it leaves the filtration plant. Information on subsurface conditions was also needed for the filtration plant itself.

The usual method of attacking a mapping problem of this sort is to make innumerable rock borings along the intended route of the tunnel and at the site of the filtration plant. Such a procedure is costly and takes considerable time and equipment. The use of electronic methods makes it necessary to drill only about six test holes at key points to tie in the plotted bedrock contours.

The City of Chicago requested Federal assistance with the initial geological problem and the work was assigned to the Geological Survey's Ground Water Branch. Arrangements were made with the Navy Bureau of Ships, Electronics Division, to use new electronic depth-finder equipment capable not only of measuring the depth to the top of the mud and gravel layers but, by penetrating these, of determining the depth to bedrock itself. In this work a principle similar to that of the fathometer is used. A signal is given off and its time of travel to the bedrock, which reflects it upward, is measured. The distance to these layers is automatically computed by the instrument and soundings are recorded continuously on graph paper. Thus, by plotting the depth to the various rock layers recorded by the depth finder as the ship traversed a series of more or less parallel courses, a group of profiles was defined upon which elevation contours were readily plotted.

The plan of sonic sounding courses was laid out by the Geological Survey and accomplished during August 1950. A 60-foot tug belonging to the City of Chicago was used to carry the equipment and cooperating engineers. The equipment used was a standard depth finder made by the Edo Corporation of College Point, Long Island, N. Y., for the Navy. It operates on the sonar principle, using a sonic signal given off by a device known as a transducer, slung over the vessel's side from a davit. Careful sextant work was required to furnish directional control for the sounding course, through sights taken on shore landmarks.

In the course of their work the Geological Survey engineers and geologists located two hidden valleys in the bedrock, both buried beneath an overburden of mud and silt. One is 130 feet deep and 2 miles long, more or less paralleling the shore and making an abrupt turn to the southeast to join a larger valley, once part of an ancient, southeasterly trending drainage system. The other is 6 miles to the north and about 80 feet in depth. It was traced for 4 miles out into the lake.

The preliminary map has been completed showing the project part of the shore area at Chicago, with 5-foot contour intervals, on the scale of 1:12,000.—Adapted from a joint release of the Geological Survey and the City of Chicago.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

PLACE NAMES IN THE SOVIET ARCTIC. Terrence Armstrong, *Polar Record,* January 1950. (Discusses difficulties encountered in the treatment of place names in the Soviet Arctic due to the varying origins and structures of those names.)

GEOGRAPHICAL SURVEYS IN HIGHWAY LOCATION. Jasper L. Stuckey, *North Carolina Engineer,* July 1950. (Discusses geology in relation to highway construction.)

ENGLISH MAPS AND MAP-MAKERS OF THE SIXTEENTH CENTURY. Edward Lyman, *The Geographical Journal,* September 1950. (A discussion of early English map making, rich in historical, scientific, and human interest.)

THE PLACE OF GEOMORPHOLOGY IN THE GEOGRAPHIC SCIENCES. Kirk Bryan, *Annals of the Association of American Geographers,* September 1950. (Discusses the place of William Morris Davis, who contributed so much to the subject during his long and active life.)

BAFFIN ISLAND EXPEDITION, 1950. P. D. Baird, *Arctic,* December 1950. (A preliminary report of the expedition, which conducted geological, glaciological, and biological investigations on the east coast of Baffin Land.)

PHYSICAL OCEANOGRAPHY OF THE NORTH POLAR SEA. H. U. Sverdrup, *Arctic,* December 1950.

CARTOGRAPHY. Albert A. Stanley, *The 1951 Americana Annual.* (Gives a brief report on domestic and foreign mapping for 1950.)

FATHOMS AND FEET, ACRES AND TONS: AN APPRAISAL. Keith Gordon Irwin, *The Scientific Monthly,* January 1951. (Discusses the origin and development of the English and metric systems of weights and measures and the possibility of achieving world uniformity.)

A NEW METHOD FOR THE ADJUSTMENT OF A NETWORK OF TRIANGULATION. G. B. Lauf, *Empire Survey Review,* January 1951.

RECONNAISSANCE MAPPING FROM TRIMETROGON AIR PHOTOGRAPHS IN THE ANGLO-EGYPTIAN SUDAN. J. W. Wright, *Empire Survey Review,* January 1951. (Outlines the main principles of planimetric mapping in the Sudan from oblique photography.)

SHORAN CONTROL. J. E. R. Ross, *The Canadian Surveyor,* January 1951. (Report of work accomplished during the 1950 season in the final adjustment of the Manitoba-Saskatchewan net.)

APPLICATION OF THE CALIFORNIA COORDINATE SYSTEM TO HIGHWAY SURVEYS AND RIGHT OF WAY ENGINEERING. H. C. Darling and L. M. Petersen, *California Highways and Public Works,* January–February 1951.

AERONAUTICAL CHART SERVICE PROVIDES WORLD-WIDE COVERAGE. *Technical Data Digest,* February 1951.

A SURVEY OF NEW ARCHEOLOGICAL SITES IN CENTRAL PERU. Philip D. Curtin, *Journal of the Washington Academy of Sciences,* February 1951. (Summary of findings of an expedition to Pataz during 1949, sponsored by the National University of Trujillo, Peru.)

TRIANGULATION PARTIES CONQUER ARCTIC TO MAP ALASKA. Karl B. Jeffers, *Civil Engineering,* February 1951. (Discusses experiences of Coast and Geodetic Survey field parties in surveying the Arctic coast of Alaska.)

MATHEMATICAL SCALE PROBLEMS. Edward B. Espenshade, Jr., *The Journal of Geography,* March 1951. (An approach to the problem of map scale through correlating both training in practical problems and education in the fields of geography and mathematics.)

SURVEYING ALTIMETER MEASURES ACCURATELY WITHIN TWO FEET. *Technical Data Digest,* March 1951. (Published by the Central Air Documents office.)

THE ALASKAN SCIENCE CONFERENCE. John C. Reed and Harold J. Coolidge, *Science,* March 2, 1951. (Part I deals with scientific research in Alaska; Part II lists participants and scientific sections organized and contains a resumé of the Conference.)

YOU CAN'T DRIVE TO SOUTH AMERICA. Leigh White, *The Saturday Evening Post,* March 24, 1951. (Provides a wealth of information concerning highway conditions between North and South America.)

LEVEL ROD GRADUATION BY PHOTOGRAPHY. Douglas L. Parkhurst, *The Military Engineer,* March–April 1951. (Describes a new process, known as Transfax, of applying the checkerwork graduations to level roads.)

NEW CHARTS FOR NEW JETS. Aeronautical Chart and Information Service, *Flying,* May 1951. (Discusses developments in charting for high-speed jet-propelled aircraft.)

BOOKS AND PAMPHLETS

MAP REQUIREMENTS OF THE FOREST SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE. Marshall S. Wright, *Revista Geográfica del Instituto Panamericano de Geografía e Historia.* (Report presented at the IV Consultation on Cartography, held at Buenos Aires in November 1948.)

BENGAL IN MAPS. S. P. Chatterjee, *Orient Longmans,* Calcutta. 1949. 105 pages. 18 Rs. (Atlas of contemporary Bengal, with 80 maps, most of which are page size.)

GEOGRAPHY OF MEXICO (Volumes I and II). Jorge L. Tomayo, *Talleres Gráficos de la Nación,* Mexico. 1949. 1208 pages, 22 plates, 587 figures, atlas, 19 maps, 34 cartograms, 10 charts. $8.65. (Treatise in Spanish on the physical geography of Mexico.)

GEOLOGY OF THE QUIEN SABE QUADRANGLE, CALIFORNIA (Bulletin 147), October 1949, and GEOLOGY OF THE MACDOEL QUADRANGLE, CALIFORNIA (Bulletin 151). *Division of Mines,* Ferry Bldg., San Francisco. 1949. (These bulletins contain descriptive material on geology and mineral deposits; colored geologic and economic mineral maps accompany the text of each publication in a separate holder.)

ANNALES HYDROGRAPHIQUES. *Service Hydrographique de la Marine.* Paris. 1950. 330 pages. Illustrations.

BOLETINS INFORMATIVOS — V ASAMBLEA GENERAL — SANTIAGO DE CHILE, OCTUBRE DE 1950. *Instituto Panamericano de Geografía e Historia.* (Contains Information Bulletins 1 to 12, inclusive, covering the Fifth General Assembly at Santiago, and a special bulletin summarizing the meeting.)

ECONOMIC AND INDUSTRIAL GEOGRAPHY. A. M. Nielson, *Pitman Publishing Corp.,* New York. 1950. 704 pages, 8 topographic plates. $6.75. (A new edition of an earlier work on fundamentals of geography, revised to include data accumulated during the author's years of teaching and adjusting his thinking to criticisms of his students and colleagues.)

GEOLOGIC DESCRIPTION OF THE MANGANESE DEPOSITS OF CALIFORNIA (Bulletin 152, Supplement to Bulletin 125). Parker D. Trask and others, *Division of Mines,* Ferry Bldg., San Francisco. 1950. (Contains a series of detailed descriptions and maps of several hundred individual manganese deposits in California. Twenty geologic maps accompany the text in a separate folder.)

GEOPHYSICAL STUDIES IN THE ANTARCTIC. T. C. Poulter, *Stanford Research Institute,* Stanford, Calif. 1950. 109 pages. $4.00. (Deals primarily with the geophysical aspects of the second Byrd Antarctic expedition.)

JOURNAL DES GEOMETRES EXPERTS ET TOPOGRAPHES—FRANCAIS. *Federation Internationale des Geometres,* Paris. (A French publication covering topographic, photogrammetric, cadastral, and other surveys. Issues for April, May, June, July, and September 1950 received for first time.)

KON-TIKI. Thor Heyerdahl, *Rand McNally & Co.,* Chicago. 1950. 304 pages, 80 illustrations. $4.00. (Story of the voyage by raft across the Pacific, which ranks among the classic small-craft voyages of the world.)

LA MEDIDA DE LAS BASES GEODESICAS. Pedro C. Sánchez, *Instituto Panamericano de Geografía e Historia,* Mexico, D. F. 1950. 151 pages. (Contains base-line measurements of the Oaxaca, Tecamachalco, Rio Verde, La Cruz, and Colombres bases in Mexico.)

LAND, MAPS AND SURVEYS. R. L. Brohier, *Ceylon Government Press,* Colombo, Ceylon. 1950. 131 pages. 10 Rs. (A review of the evidence of land surveys as practiced in Ceylon from earliest known periods to 1950.)

MINERAL COMMODITIES OF CALIFORNIA (Bulletin 156). *Division of Mines,* California. 1950. 443 pages.

THE STUDY OF GEOGRAPHY. J. M. Mogey, *Oxford University Press,* London. 1950. 164 pages. 5s.

THE TEACHING OF GEOGRAPHY: A DYNAMIC APPROACH. Roderick Peattie, *Appleton-Century-Crofts, Inc.,* New York. 1950. 185 pages. (Challenges the teacher to do a better job.)

GEOGRAPHY IN THE TWENTIETH CENTURY. Edited by Griffith Taylor, *Philosophical Library, Inc.,* New York. 1951. 630 pages. $8.75. (A study by 20 American, British, and Continental geographers of the growth, fields, techniques, aims, and trends of modern geography. Of special interest is a chapter on "Geography in Practice in the Federal Government, Washington.")

ISAIAH BOWMAN. Gladys M. Wrigley, *Geological Society of America,* New York. 1951. 59 pages. $0.50. (A brief biography written as a memorial.)

PHYSICAL GEOGRAPHY. Arthur N. Strahler, *John Wiley & Sons, Inc.*, New York. 1951. 442 pages, 514 illustrations. $6.00. (Presents physical geography as a basic earth science.)

A RESEARCHER'S GUIDE TO THE ARMY MAP SERVICE LIBRARY. *Army Map Service*, Department of the Army, Washington 16, D. C. 1951. 57 pages, 26 illustrations. (Describes the facilities of the library and serves as a guide to their use.)

STRUCTURAL GEOLOGY OF NORTH AMERICA. A. J. Eardley, *Harper & Brothers*, New York. 1951. 620 pages, 16 maps, 750 illustrations. $12.50. (Describes in detail the structural evolution of the continent and includes information on economic aspects, petroleum, and metals.)

—A. A. STANLEY

DISTINCTIVE RECENT MAPS

The Geological Association of Canada and the Geological Society of America have collaborated in the preparation of a new *Tectonic Map of Canada* (1950). It measures 40 by 57 inches and is on the scale of 1:3,801,600. The project committee included Duncan R. Derry, Chairman, Theo A. Link, John S. Stevenson, and J. Tuzo Wilson. Lithography is by Williams & Heintz Company of Washington, D. C. Sedimentary and volcanic and intrusive rocks are differentiated according to geologic age by contrasting colors. Structural features are indicated by appropriate symbols. A table listing "Compilation and Sources of Material" is included.

The Army Map Service has prepared a new (June 1950) map showing *Major Army, Navy and Air Force Installations in the United States* (AMS No. 8205). It shows Army, Navy, and Air Force headquarters and installations, Army areas, Naval districts, and various categories of air bases. This large wall map is on the scale of 1:3,500,000 and measures 38 by 55 inches.

Tribal and Linguistic Distributions of South America is the title of a new map published by the Bureau of American Ethnology of the Smithsonian Institution. It accompanies volume 6 of the Bureau's Bulletin. Tribal locations on the map are according to Julian H. Steward and linguistic distributions according to J. Alden Mason. Some 75 different language regions of South American Indians are mapped. This large colored map measures 45 by 32 inches and is on the scale of 1:7,500,000.

Petroleum concessions for some eight oil companies are demarcated on the *Mapa de la República de Colombia*, published in 1948 by the Servicio Técnico, Ministerio de Minas y Petróleos of Colombia. The map shows the locations of existing concessions and of areas contracted for exploration and exploitation as of July 1, 1948. The dimensions of the map are 40 by 32 inches and the scale is 1:2,000,000.

A large *Mapa del Perú* was published in 1950 by the Instituto Geográfico Militar of that country. It is printed on 8 sheets, each of which measures 20½ by 30 inches. The scale is 1:1,000,000. Brown contours, with an interval of 250 meters, indicate relief. Water features are shown in blue. International, departmental, and provincial boundaries are delimited. Railroads, airports, and several classes of roads are among the cultural features mapped. Small inset maps show geodetic and astronomic control and indicate relative reliability of compilation material.

Attention is called to the series of *Wenschow Reliefkarten* which has recently been made available in this country. These attractive wall maps, designed for classroom use, graphically depict relief by a combination of hypsometric tints and shading. The effect suggests a photograph of a three-dimensional relief model. The maps are published by

Karl Wenschow of Munich with the approval of the U. S. Office of Military Government.

The following maps, with dates and scales indicated, have been received by the Library of Congress: World (1947[?]) 1:15,000,000; Africa (1947) 1:7,500,000; Northern Asia (1947) 1:7,500,000; Europe and Near East (1947) 1:7,500,000; Niedersaechsen (1947) 1:250,000; Südbayern (1947) 1:200,000; Hessen (1947[?]) 1:600,000; and Südbayern (1947) 1:750,000.

In recognition of the bi-centennial of the birth of Goethe, Ernst Heimeran Verlag of Munich published, in 1949, a *Karte von Goethe's Lebensreise.* The map traces the wanderings of the poet through central, eastern, and southern Germany, eastern France, Switzerland, and Italy. It is artistically drawn by A. Woelfle and water colored by hand. Inset maps of the city of Weimar and of the Sachsen-Weimar-Eisenach region are included. Sketches of six Goethe landmarks occupy the left portion of the sheet. The map, with illustrations, measures 23½ by 19 inches. No scale is given.

The British Electric Authority issued in April 1950 a map showing *Generating Divisions of England and Wales.* Generating, transforming, and switching stations; transmission lines of various capacities; and other pertinent data are mapped on the Ordnance Survey's 10 mile to an inch base. The over-all dimensions of the map are 47 by 34½ inches. The London Division is shown on an enlarged inset.

Mapa de la Producción Eléctrica de España cartographically portrays various aspects of electric power developments in Spain. It shows dams, powerhouses, and transmission networks in operation, under construction, and projected, as well as limits of the several watersheds. Capacity in kilowatts is indicated for the powerhouses. This colored map measures 21½ by 29 inches and is on the approximate scale of 1:1,675,000. The publisher is " Exclusivas Triunfo," of Bilbao, Spain.

The Economic Section of the American Embassy at Athens issued, in November 1947, the second edition of *A General Economic Map of Greece.* It is on the scale of 1:2,000,000 and measures 20 by 18 inches. Contrasting colors distinguish agricultural, manufacturing, mining, transportation, and trade localizations. Names of specific agricultural products are lettered on the map in appropriate places, initial keys identify types of livestock, and distinctive small symbols indicate the nature of manufacturing specializations. A small Administrative, Mineral, and Population Map is included as an inset. The map was compiled by Paul L. Anastassiades and drafted by Horace H. Smith. It was printed through courtesy of the Greek Army Geographical Service.

The administrative subdivisions of the Soviet Union are outlined on Freytag and Berndt's map of *Union Sozialistisches Sowjetrepubliken,* published in Vienna during 1950. In addition to internal political boundaries, it shows roads, railroads, oil pipe lines, and shipping routes. Different symbols group the settlements according to population. Primary and secondary divisions of the Soviet Union are listed below the map. The dimensions are 31 by 38 inches, and the scale is 1:10,000,000.

A three-sheet topographic map of *The Hashemite Kingdom of the Jordan* was published, in 1949–50, by the Department of Lands and Surveys of the Jordan. The map is on the scale of 1:250,000. Relief is indicated by a combination of contours and color gradients. Roads, administrative and international boundaries, settlements, antiquity sites, wireless stations, and police posts are shown on the map. Each sheet measures 30 by 26 inches.

A separate edition of this map, showing more generalized relief, provides a base on which archeological "Sites of Special Interest" are indicated.

India, Architectural and Sculptural Monuments, illustrates and locates some of the historical and artistic treasures of India. Small photographic reproductions of the monu-

ments are superimposed upon the map at or near their actual sites. Even at the necessarily reduced scales they give a taste of the grandeur and beauty of the original buildings and sculptures. The map was designed and prepared by Madhuri Desai and published by the Government of India "for a greater appreciation of the rich heritage of Indian culture." It measures 38 by 25½ inches and is on the scale of 1 : 10,200,000. The Legation of India at Bern is the publisher.

The *New Map of Japan*, published by Nihon Chizu Company of Tokyo, shows relief by altitude tints, outlines prefectures, and indicates roads, railroads, national parks, and several classes of inhabited centers. All place names are in English, and a brief glossary gives English and Japanese equivalents for geographical features. Inset maps of Hokkaido, Nikko, Hakone, and Izu; Tokyo and Yokohama; and Kobe-Osaka and Kyoto are included. The map measures 28 by 41 inches and is on the scale of 1 : 1,500,000. A keyed index includes approximately 600 place names.

Generalized relief of Somaliland is shown by means of hypsometric tints on a map published in 1949 by Servicio Cartografico, Ministero Dell'Africa Italiana, and entitled *Somalia, Carta Dimostrativa Fisico Politica*. English and French Somaliland and portions of Ethiopia and Kenya Colony are included. The scale is 1 : 2,000,000 and the dimensions 38 by 25½ inches. The city of Mogadiscio and the environs of Margherita, Merca, and Villaggio Duca degli Abruzzi are shown on enlarged inset maps.

A *Map of Broadcasting of the United States and Canada* was issued in 1950 by Broadcasting Publications, Inc., of Washington, D. C. It was prepared in collaboration with Walter P. Burn of Middlebury, Vt. Cities with standard and FM broadcasting stations and telecasters are designated with appropriate symbols. Inset maps show the same data for Alaska, northern Canada, Hawaii, Puerto Rico, and a number of the more densely settled areas of the United States. The map is colored in various shades of blue. It measures 23½ by 34 inches and is on the approximate scale of 1 : 5,750,000.

Surficial Geology of New Hampshire is cartographically portrayed on a map published in 1950 by the New Hampshire State Planning and Development Commission. It is based on data from the U. S. Geological Survey, the New Hampshire State Highway Department and the New Hampshire State Planning and Development Commission. Geology is by James Walter Goldthwait, R. P. Goldthwait, L. Goldthwait, R. J. Lougee, T. R. Meyers, L. R. Page, G. W. White and others. The map is sub-titled "James Walter Goldthwait Memorial Edition." It is on the scale of 1 : 250,000 and measures 48 by 26 inches.

In November 1950, the John Carter Brown Library issued a full color facsimile of Robert Ryder's manuscript map of Long Island, drawn about 1675. The original vellum map, from which the reproduction was made, is one of 48 manuscript and printed maps which comprise the so-called Blathwayt Atlas. This collection of historical maps is one of the notable holdings of the John Carter Brown Library.

Ryder's manuscript has been beautifully reproduced in collotype by the Meriden Gravure Company. It measures 23 by 31 inches and includes, besides Long Island, Staten and Manhattan Islands, the region now included in The Bronx and Westchester County, and part of the Connecticut and New Jersey shores. The map is accompanied by a "Historical Note on the Robert Ryder Map of Long Island of About 1675."

Roads and railroads of Mexico are featured on a new map published by Roberto E. Herrera at Guadalajara, Mexico, and entitled *República Mexicana Carreteras y Ferrocarriles*. Roads and railroads are hand colored on a blue print base. Different types of road surfacing are indicated, and highway distances between towns are given in kilometers. An inset map shows the air service network. The map measures 24 by 35 inches. No scale is indicated.

—Walter W. Ristow

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession.

—EDITOR

Topographic Maps

THE FOLLOWING quadrangle maps, topographic or planimetric, were published between March 1 and May 31, 1951, by the U. S. Geological Survey (New Publications Lists 512 through 514). Planimetric maps (no contours) are indicated in the list by the letter (P) following the name. All maps are available with or without the green overprint which indicates woodland. The quadrangle name is shown in capital letters, followed by the county name in upper- and lower-case letters. Since many quadrangle maps extend into several counties, only that county name is given which contains the place or feature for which the quadrangle is named. For example, the quadrangle SIPSEY, in *Alabama*, is in parts of Cullman, Walker, and Jefferson counties, but only Walker is shown because the town of Sipsey is in that county.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo.

Alabama

CORDOVA—Walker†
OAKMAN—Walker
SIPSEY—Walker
TRIANA—Madison
TUTWILER SCHOOL—Walker
WILEY—Tuscaloosa

Alabama-Tennessee

SALEM—Limestone
UNION HILL—Limestone

Alaska

ICY BAY (D-2 & D-3)*—Third Judicial Division
KODIAK (D-2)*—Third Judicial Division†

Arkansas

ALMA—Crawford
BARBER—Logan
BURNVILLE—Sebastian
GREENWOOD—Sebastian†
HUNTINGTON—Sebastian
IONE—Logan
LAVACA—Sebastian
MULBERRY—Crawford
VAN BUREN—Crawford

Arkansas-Oklahoma

FORT SMITH—Sebastian
HACKETT—Sebastian
SOUTH FORT SMITH—Sebastian

California

ALDERPOINT*—Humboldt
BISHOP*—Inyo
CHICAGO PARK—Nevada
MT. TOM*—Inyo
NEWPORT BEACH—Orange†
NORTH BLOOMFIELD—Nevada†
PETALUMA POINT—Sonoma
PIKE—Sierra
REEDLEY—Fresno
TAFT—Kern†
TAYLOR WEIR—Tulare†

Colorado

ERIE—Weld
HOLY CROSS*—Eagle
KEENESBURG—Weld
LONGMONT—Boulder
MASTERS—Weld
ROPER SCHOOL—Adams†

Connecticut

WEST TORRINGTON—Litchfield†
WINSTED—Litchfield

Connecticut-Massachusetts

TARIFFVILLE—Hartford

Florida-Alabama

GLENDALE*—Walton
GRACEVILLE—Holmes

Idaho

BLACKBIRD MOUNTAIN*—Lemhi†
DRY VALLEY—Caribou†
JOHNSON CREEK—Caribou†
LOWER VALLEY—Caribou†
PACKSADDLE MTN.*—Bonner
SNOWDRIFT MOUNTAIN—Bear Lake-Caribou
STEWART FLAT—Caribou†
THOUSAND SPRINGS—Gooding
UPPER VALLEY—Caribou†

Illinois

CHAMPAIGN - URBANA AND VICINITY—Champaign ‡

* Indicates 15-minute quadrangle; all others are 7½-minute quadrangles.
† Indicates map lies wholly within county named.
‡ Indicates availability in either a contour or a shaded-relief edition.

HIGHLAND PARK—Lake
McLEAN*—McLean

Indiana

GEORGIA—Lawrence
WAWASEE—Kosciusko

Iowa

ADEL*—Dallas

Kansas

BIRD CITY SOUTH*—Cheyenne
BONNER SPRINGS—Wyandotte
McDONALD*—Rawling
McCLOUTH—Jefferson
MIDLAND—Douglas

Kentucky

BORDLEY—Union
MORGANFIELD—Union†
MOUNT WASHINGTON—Bullitt
POOLE—Webster
ROBARDS—Henderson
SEBREE—Webster†
WAVERLY—Union

Kentucky-Ohio

FRIENDSHIP—Scioto

Louisiana

RUSTON*—Lincoln Parish
WINNFIELD*—Winn Parish

Maine

HARRINGTON—Washington†
JONESPORT—Washington†
MACHIAS BAY—Washington†

Maryland

CHESTERTOWN*—Kent
GUNPOWDER NECK—Harford
MIDDLE RIVER—Baltimore†

Maryland-Delaware

CECILTON*—Cecil

Michigan

BIG BRADFORD LAKE—Otsego
GRAYLING—Crawford†
JOHANNESBURG—Otsego†
K P LAKE—Crawford
LOVELLS—Crawford
OTSEGO LAKE—Otsego†
PERE CHENEY—Crawford
ROSCOMMON NORTH — Roscommon
TURTLE LAKE—Otsego†
WAKELEY LAKE—Crawford†

Missouri

ALMA—Lafayette
BATES CITY—Lafayette
BENJAMIN—Lewis†
BUFFALO NW—Dallas
CAMDEN—Ray
CLIQUOT—Polk†
DOVER—Lafayette
HIGGINSVILLE—Lafayette†
LA BELLE—Lewis
LEWISTOWN—Lewis†
URBANA—Dallas
WILLIAMSTOWN—Lewis†

Missouri-Illinois

LAGRANGE—Lewis

Nebraska

HOAGLAND*—Logan
KILPATRICK LAKE*—Box Butte
KOSHOPAH*—Brown
MARSLAND*—Dawes
SENECA*—Thomas
STEVERSON LAKE*—Cherry†

New York

ALEXANDER—Genesse†
ATTICA—Wyoming
HARFORD—Cortland
SAG HARBOR—Suffolk†
WEST BAINBRIDGE — Chenango†

North Carolina

BEAUFORT—Carteret†
CAPE LOOKOUT—Carteret†
CORE CREEK—Carteret
HARKERS ISLAND—Carteret†
STYRON BAY—Carteret†

Ohio-Kentucky

CONCORD—Lewis

Oregon

LONG CREEK*—Grant†
SUSANVILLE*—Grant†

Pennsylvania

PITTSBURGH WEST—Allegheny†

South Dakota

SCHOOL SECTION BUTTE—Jackson
WANBLEE NW—Washabaugh

Tennessee

BEANS CREEK—Franklin†
BROWNSVILLE—Haywood†
CAMPBELLS STATION—Maury
ELKTON—Giles†
FRANKEWING—Giles
PULASKI—Giles†
RIVES—Obion†
SUNNYHILL—Haywood†
TAFT—Lincoln†
TARPLEY—Giles†

Texas

BEREA—Houston†
CENTRALIA—Trinity
CROCKETT—Houston†
CROCKETT NE—Houston†
GRAPELAND—Houston†
IRA—Scurry
IRA SW—Borden
KENNARD—Houston
KENNARD NE—Houston

Utah

PELICAN POINT—Utah†

Washington

BODIE MOUNTAIN*—Ferry
CURLEW*—Ferry†
KETTLE FALLS*—Stevens
ORIENT*—Ferry
REPUBLIC*—Ferry†
SHERMAN PEAK*—Ferry†
TOGO MOUNTAIN*—Ferry†
WAUCONDA*—Okanogan

West Virginia-Maryland

CRESAPTOWN—Allegheny
KEYSER—Mineral

West Virginia-Virginia

FORT SEYBERT*—Pendleton

Wisconsin

CUMBERLAND* (P)—Barron
RICE LAKE* (P)—Barron

Wisconson-Minnesota

MILLTOWN* (P)—Polk

Wyoming

CEDAR HILL—Platte
COLEMAN BUTTE—Platte†
HELL GAP—Goshen
HERMAN RANCH—Platte†
MOORE SPRING—Goshen†

In addition to the standard series of quadrangle maps, reconnaissance maps at the scale of 1 : 250,000 are being published for both the continental United States and Alaska. Maps in this series published in the period include the following:

Alaska

BENDELEBEN‡—Second Judicial Division†
FAIRBANKS‡—Fourth Judicial Division†
JUNEAU—Third Judicial Division
KANTISHNA RIVER—Fourth Judicial Division†
TALKEETNA—Third Judicial Division

Arizona-California-Nevada

KINGMAN‡

California

BAKERSFIELD‡
FRESNO‡
GOLDFIELD†
SACRAMENTO‡
SAN FRANCISCO‡
SAN JOSE‡
SAN LUIS OBISPO‡
SANTA CRUZ‡
SANTA MARIA‡
SANTA ROSA‡

California-Nevada

DEATH VALLEY‡
MARIPOSA‡
WALKER LAKE‡

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the Congress. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR

"METES AND BOUNDS"

K. T. ADAMS*—After reading the opening paragraphs of Mr. Ainsworth's interesting paper "Metes-and-Bounds Location Problems in New England," published in the April–June 1950 number of SURVEYING AND MAPPING, I began to wonder about this expression "metes and bounds." Mr. Ainsworth merely whetted my curiosity by stating that he looked the words up in "Webster" and sketchily reported a little of what he found.

I had always assumed, without much basis, that the word "metes" meant "measurements" or the courses in a survey, and that "bounds" meant the marks set at the turning points.

Now, I am not an etymologist, but just to give someone who knows better an opportunity to prove me wrong, I am going to venture the opinion that this expression "metes and bounds" is probably another of these linguistic couplets wherein the two words have, or originally had, the same meaning, one being derived from Anglo-Saxon and the other from Norman French. Our language, particularly our legal language and our religious language, contains any number of these anachronistic couplets. Everyone is familiar with "my last *will* and *testament*," "I hereby *give* and *devise*," "*begin* and *commence*," "*yearly* and *annual*," "*mild* and *gentle*," in each of which couplets the first word is derived from Anglo-Saxon and the last from Norman French; and with "by this *sign* and *token*," "his *power* and *might*," in which the first word is French and the second English.

These and similar couplets originated this way. After the Battle of Hastings in 1066 the Norman French ruled England and the Anglo-Saxons were driven out of the government and the church; the court, the clergy, the large land owners, and the military were all Normans, and Norman French was exclusively spoken in these circles, whereas the mass of the common people spoke only English. This situation continued for 200 years before any perceptible mixture of the languages took place. By a statute of 1362, English had to be used in all law courts, replacing French. But when the higher class used English they naturally intermixed French words and expressions in it, especially when they thought the French had a more specific meaning, or even sometimes adding the French word where it was undoubtedly the equivalent of the English.

Thus arose the use of these couplets in cases where it was important that there be no misunderstanding, as in contracts, wills, etc.; and why not also in the description of land in a deed?

* Rear Admiral, U.S. Coast and Geodetic Survey (Retired).

"THE NEED FOR COLLEGE TRAINING IN GEODETIC SURVEYING"

SERGE A. EMERY.*—My article on "The Need for College Training in Geodetic Surveying" (October–December 1950 issue of SURVEYING AND MAPPING) was intended to demonstrate the need for college education for a new type of engineers—geodetic surveying engineers. These engineers should be able to solve all kinds of problems *in all branches of surveying and geodesy*, including the military implications of geodesy and geodetic engineering.

Mr. Schmidt ("Comment and Discussion," April–June 1951 issue of SURVEYING AND MAPPING) criticized my use of the words "geodetic," "geodesy," and "geodetic surveying." However, it is rather difficult to characterize, briefly and distinctly, the immense field of activities open to the new type of engineers.

I agree with the expression used by Mr. Schmidt that ". . . contemporary engineering education is predicated . . . upon the need to develop an inquiring attitude and a resilient mind. . . ." Civil, mechanical, and other engineers attend colleges for about 5 years in order to reach this goal. However, Mr. Schmidt recommends that "superior instruction at the graduate level for [only] 1 year in geodetic engineering, plus collateral work in related areas, offers . . . the soundest basis for enhancing intrinsic interest in this subject." This is not understandable, as it deals with reaching the same goal for geodetic surveying engineers. The problem can be solved only in a radical manner, i.e., by a complete college education in surveying and geodesy, as it has been solved in Europe, where more than 10,000 geodetic surveying engineers have graduated in the last 50 years. We cannot forget surveying and geodesy and expect to keep our country up to date in this field.

Concerning demands for geodetic surveying engineers, there were more than 100 offers listed in the *New York Times* alone during 1950. These included positions which could be occupied by geodetic surveying engineers (office engineers, computers, experienced chiefs of parties, etc.) only in property and engineering surveying, without mentioning offers made in other large cities and by other agencies. Considering the permanent increase of population and, consequently, the augmentation of the value of land, there will be a constant and increasing demand for the services of geodetic surveying engineers.

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* Civil Engineer, New York, N. Y.

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Air Photos Better Than Ground Measurements

PRE-INVASION AERIAL MEASUREMENTS of the Inchon beachhead were more accurate than ground measurements made after the invasion. Amron H. Katz of the Photographic Laboratory, Wright Field, Ohio, told a recent meeting of the American Society of Photogrammetry that the differences between the aerial measurements from photographs and the post-invasion ground measurements averaged about 6 inches. Evidence points to the aerial measurements as being more accurate, he stated.

Novel methods of interpreting were developed on the spot to make these very exact measurements of the seawall heights at the two invasion beaches at Inchon. —*Science News Letter*, January 20, 1951.

CONGRESS NEWS

Secretary's Report

(Presented at Eleventh Annual Meeting, June 20, 1951)

FOLLOWING the Tenth Anniversary Meeting last June, A.C.S.M. business was conducted through the remainder of President Bauer's term with one regular meeting of the Board of Direction, one regular meeting of the Executive Committee, and one special Executive meeting. The major items of that period were:

(*a*) Completion of details concerned with incorporating all acts of A.C.S.M. previous to legal incorporation into the corporate body of A.C.S.M.;

(*b*) Transmittal of an informal report on "Surveying in the United States" to the New Zealand Conference of British Commonwealth and U.S.A. Survey Authorities and delegation of Member Earl G. Harrington, who was the official United States Representative to the conference, as the A.C.S.M. representative; and

(*c*) Authorization for formation of the Texas Section of A.C.S.M. in Houston on due petition by an active group from that area—which section now is in full bloom under the chairmanship of G. W. Herzog and is well represented at this meeting.

A Resolution of Condolence was sent on November 16, 1950, to the family of Jack Dodds of Iowa, a past president of A.C.S.M., who passed away on November 3.

On January 1, 1951, our present president, Gerald FitzGerald, took over the reins of A.C.S.M. To date, including a Monday-noon meeting on June 18, A.C.S.M. has held three Board of Direction meetings and the same number of Executive Committee meetings. Major items of activity, in summary, are:

(*a*) Approval and appointment of officers and chairmen, approval of budget, nominating and balloting activation, annual meeting planning, and routine matters of "running" the Congress.

(*b*) Authorization to form the pro tempore Division on Education, which has been extremely active at this Eleventh Annual Meeting (and which we can now say is an established division of A.C.S.M.).

(*c*) Activation of the Publications Committee along the lines recommended in the report "Statement of Duties of Publications Committee and Editor-in-Chief," as revised during February 1951 by the Special Committee on Publications Policy, which was appointed for the purpose of review.

As you have possibly already heard from past-President Wright's panel discussion on Monday and from past-President and present Membership Chairman Borden, membership in A.C.S.M. is ever increasing. The figure, in round numbers, is very close to 2,500. Of particular import is the local section interest and the affiliation with A.C.S.M. of organized professional surveying groups. A petition by 135 A.C.S.M. members in northern California for the formation of a Northern California Section of A.C.S.M. was acted upon and approved during this meeting. That makes two sections in California and one in Texas. Ap-

proval of the Virginia Association of Surveyors, Inc. as an institutional member of A.C.S.M. was also given during this meeting. As you know, the Georgia Association of Registered Land Surveyors and the Michigan Society of Registered Land Surveyors were already institutional members. Another Institutional Member, in a practical sense, is the Nassau-Suffolk Civil Engineers, Inc., of New York.

To close, I would like to mention that A.C.S.M. is growing, and the work to be done is also increasing. It will take a tremendous amount of individual member effort on the part of all the membership to perform the tasks ahead. This is a challenge to each of you, remembering that you pay your dues for the privilege of participating and that A.C.S.M. committee activities need participators.

WALTER S. DIX
Secretary

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Honorary Membership Awarded to Ned Sayford

In presenting a certificate of honorary membership to Mr. Sayford at the Eleventh Annual Meeting of the American Congress on Surveying and Mapping, President FitzGerald gave the following brief biographical sketch:

Our very good friend and long-time member, Mr. Ned H. Sayford, has recently retired from active service with the Tennessee Valley Authority. For almost 18 years he headed the Maps and Surveys Branch of the TVA, an organization whose contributions to modern surveying and mapping techniques are well known to most of us.

Mr. Sayford was graduated with a degree in civil engineering from Lehigh University in 1908, and was a member of Tau Beta Pi. He was vice president of the Morgan Engineering Company, with headquarters in Memphis, Tenn., for many years previous to his TVA work. At that time he was primarily concerned with general engineering and management of a multitude of projects for flood control, drainage, irrigation, stream regulation, and other water-use or water-control developments. It was no doubt during this period that he came to appreciate the true value and real economy of adequate basic surveys and maps.

In view of this background, it was quite natural, when placed in charge of the TVA's huge surveying and mapping programs in 1934, that he insisted on permanent-value, long-range mapping programs, and high standards of workmanship. There can be little doubt that the TVA has had profound influence on the development of modern surveying and mapping techniques, and perhaps more important, in bringing about full use of surveying and mapping products by engineers, planners, and economists. This in considerable measure has been due to the fortunate circumstance that Mr. Sayford was in a strategic spot within TVA, and made his influence felt.

It is for his contributions to the development of modern mapping procedures, and to the education of engineers as to the economy of high-standard surveys and maps, that Mr. Sayford is today being honored by the ACSM. On behalf of the entire membership of this society, I am pleased to bestow on him this certificate of honorary membership—an honor that has so far been sparingly bestowed. In this case I am sure we will all agree that it is a fully merited, well deserved, honor. (The certificate was accepted for Mr. Sayford by William S. Massa.)

Report of Special Committee on Map Scales

(Presented at the Eleventh Annual Meeting)

At the Ninth Annual Meeting of the American Congress on Surveying and Mapping, held in June 1949, a Resolution was passed which read as follows:

WHEREAS, standard topographic quadrangle maps of the United States, territories, and possessions are now published on a multiplicity of scales, and it may be in the public interest to reduce the number of these scales, be it therefore

RESOLVED, that a special committee of the American Congress on Surveying and Mapping be appointed to investigate and study the different topographic map scales in use in the United States, that this committee invite a thorough discussion of the subject, and recommend at the next annual meeting any practical policies that the American Congress on Surveying and Mapping should endorse with a view of standardization on one series of scales for topographic and quadrangle maps of the United States, territories, and possessions, and be it further

RESOLVED, that copies of this resolution be forwarded to the Director of the Bureau of the Budget and to the Director of each of the Federal agencies engaged in topographic mapping.

In carrying out the duties imposed by this Resolution the president, Marshall S. Wright, appointed Helmuth Bay as chairman of a Committee on Map Scales, and instructed him to select committee members, make an investigation, and submit a report at the earliest possible annual meeting. The other members of the committee subsequently chosen were: Prof. F. M. Feiker, Dean, School of Engineering, George Washington University, Washington, D. C.; Prof. G. Brooks Earnest, Dean, School of Engineering, Fenn College, Cleveland, Ohio; Robert L. Wing, Division of Water Resources, Sacramento, Calif.; and Dr. Carl Mapes, Director of Research, Rand McNally & Company, Chicago, Ill.

REPORT OF THE COMMITTEE

In line with the instructions of the resolution relating to the multiplicity of United States topographic map scales, the committee requested and obtained statements from each of the following Government agencies: Geological Survey, Coast and Geodetic Survey, Department of Agriculture, and the Corps of Engineers. These statements contain a detailed discussion of the scales on which these agencies make and produce topographic maps, the reasons and justification for their preference of these scales, and the methods and techniques employed in producing the maps.

Conversations were also held from time to time with these agencies for further clarification, and each member of the committee received a complete file of all records for his individual study and consideration.

As a result of the committee's studies and deliberations, the following conclusions have been reached:

1. If the United States Government was beginning from scratch to make topographic maps of the United States, it would be most desirable, as well as economical, to first agree upon such standard scales as would be acceptable to all the various Government agencies who make and use maps.

2. When topographic mapping actually began in 1886, the mile-and-fraction-thereof scales seem to have been quite acceptable, even to the military branches who brought out their own Provisional Editions of topographic sheets on similar fractional scales.

3. So far as the general public is concerned, we doubt whether they give much

thought as to which scale is preferable. People, in general, use topographic maps for reference purposes only and without regard to close measurements. Map stores sell the 1 : 63,360 series, the 1 : 62,500 series, and the 1 : 50,000 series with little, if any, objections from customers as to difference in scale.

4. The preference by some agencies for the so-called military scale breakdown has been stimulated largely through the Nation's international military involvement during the recent world wars. This situation made the determination and acceptance of standard scales an absolute necessity. It is, therefore, not only natural, but necessary, that the United States Defense agencies prosecute their topographic map-making activities in conformance with set international standards so that they will properly synchronize with, and efficiently aid, standardized instruments, material, and practices.

5. The civilian topographic agencies, having for about 65 years made thousands of topographic maps and printed thousands of reports embellished therewith, state that they would find it extremely impractical and costly to convert to a different set of map scales. To change and convert would effect and cause hardship to not only the map-making agencies themselves, but all the departments, offices, and branches of the agencies who use the maps.

6. Conversion of, and producing new editions of, existing topographic maps to new scales is not only costly in itself, but would create much confusion and necessitate great change in practices in state and county offices as well. County agents, extension officers, conservation advisors, and the like maintain that a scale which permits the direct use of a ruler in inches and fractions thereof as a basis of determining acreage is extremely desirable. The inch-to-the-mile and fraction thereof scale permits this civilian use.

7. A number of English-speaking countries, Canada and England among them, use more than one set of topographic map scales. In discussing this with the Canadian mapping agencies they indicated that they felt that it was desirable to give an agency a map on the scale it required.

8. An agency should be permitted to have topographic maps on the scale with which it can most easily and economically carry on its functions.

9. A great saving of United States taxpayers' money can be made if the topographic map-making agencies *make the drawings from which the maps are printed on scales which will permit enlargement or reduction to the scales required by the map-using agencies.* For example, if a drawing is prepared on a scale which will permit its reproduction on scales of 1 : 50,000, 1 : 62,500, 1 : 63,360, or in the vicinity thereof, the public is burdened with only one compilation cost. This matter is simply one of cooperation between the agencies concerned, and it has been carried on here in the United States since the end of World War II. The same technique is employed in Canada.

10. We feel that, in view of the conditions stated above, the forcible establishment of, and the conversion of maps to, a single standard set of scales for all United States topographic maps at the present time would be more costly than to retain the multiple scales now desired by the agencies, provided that the compilation and neat drawings are made upon such agreed-upon scales that they can be reproduced at the varying scales desired and requested by the agencies using them.

It is further believed that the conversion of existing topographic maps to a new set of scales would, in addition to being costly, be extremely time consuming, and inasmuch as everyone agrees that the prime effort in topographic mapping should be to complete the United States Topographic Map as soon as possible, all energies should be devoted toward that end.

F. M. Feiker
G. Brooks Earnest
Robert L. Wing
Carl Mapes
Helmuth Bay, *Chairman*

Resolutions Adopted at Eleventh Annual Meeting

The following Resolutions were unanimously adopted by the American Congress on Surveying and Mapping at the Eleventh Annual Meeting at Washington, D. C., June 20, 1951.

RESOLUTION ON TOPOGRAPHIC MAPPING ALONG NATIONAL SYSTEM OF INTERSTATE HIGHWAYS

WHEREAS, the National System of Interstate Highways has been designated and located so as to connect by routes as direct as practicable the principal metropolitan areas, cities and industrial centers and to serve the national defense, as required by the "Federal Aid Act of 1944," and

WHEREAS, an essential requirement in the establishment of the most economical and satisfactory location of a highway is the availability of modern accurate topographic maps of suitable scale and content, and

WHEREAS, the National Topographic Mapping Program is intended to serve all general map needs, including those related to highway development, be it therefore

RESOLVED, that the American Congress on Surveying and Mapping endorse the initiation of a program of mutual cooperation between the State Highway Departments, and the Federal mapping agencies to promote the development of needed maps in the areas adjacent to the National System of Interstate Highways, and be it further

RESOLVED, that the American Congress on Surveying and Mapping appoint a committee to encourage the development of a program of topographic mapping in these areas, to explore the nature and extent of map needs for this and other highway developments, to arrange for cooperation between the State Highway Departments, the American Association of State Highway Officials, and the agencies engaged in the program of quadrangle mapping for the Federal Government, and be it further

RESOLVED, that copies of this resolution be forwarded to the Commissioner of the United States Bureau of Public Roads; to the officers of the American Association of State Highway Officials; to the Chief Engineer of each Highway Department in the United States, its Territories and Insular Possessions; to the Director, U. S. Coast and Geodetic Survey; the Director, U. S. Geological Survey; the Chief of Engineers, Department of the Army; and the Chief, U. S. Forest Service.

RESOLUTION ON A POLICY ON HIGHWAY SURVEYS

WHEREAS, the value of surveys for highways is dependent upon the accuracy attained through execution in accordance with a recognized standard, and

WHEREAS, the American Congress on Surveying and Mapping, recognizing the need for a criterion that may be used as a guide in improving and standardizing survey practice, has formulated "A Policy on Highway Surveys" which specifies desirable limits of accuracy for length and angular measurements and determination of elevations in highway surveys, and

WHEREAS, the adoption and use of these standards will establish procedures resulting in dependable surveys which will serve beyond their initial purpose and become a continually increasing asset in the planning, design, construction, and maintenance of highways, be it therefore

RESOLVED, that the American Congress on Surveying and Mapping urge the adoption of this "Policy on Highway Surveys" by the American Association of State Highway Officials, and be it further

RESOLVED, that copies of this resolution be forwarded to the Commissioner of the United States Bureau of Public Roads; to the officers of the American Association of State Highway Officials; and to the Chief Engineer of each Highway Department in the United States, its Territories and Insular Possessions.

RESOLUTION ON TRAINING IN THE SCIENCES OF SURVEYING AND MAPPING

WHEREAS, the acute and ever increasing shortage of men trained in the surveying and mapping sciences has come to the attention of many of the several meetings and Division discussions of this Congress, and

WHEREAS, the theme of this meeting of the Congress is that "Surveys and Maps are the Basic Blueprints for Defense, for Peace, for Development and for Progress," now therefore be it

RESOLVED, by the American Congress on Surveying and Mapping at its final business session on June 20, 1951, at the Shoreham Hotel, Washington, D. C., that it call upon the educational institutions of the Americas to recognize and assume their patriotic duty and responsibility to train more men more adequately in these sciences by: (*a*) increasing the time of surveying courses already offered, (*b*) establishing additional courses in these fields, (*c*) establishing surveying and mapping options and curricula, and (*d*) establishing additional graduate courses in these sciences, and be it further

RESOLVED, that copies of this resolution be forwarded to the responsible officers of educational institutions of the Americas and that it be published in the next issue of the Journal.

RESOLUTION ON AWARDS

WHEREAS, it lies within the aims and purposes of the American Congress on Surveying and Mapping to stimulate the interest of college students in working with maps, be it therefore

RESOLVED, that the Congress establish a suitable annual award to be presented for the best college undergraduate or graduate paper on mapping or use of maps.

RESOLUTION ON THE ELEVENTH ANNUAL MEETING

RESOLVED, that the members of the American Congress on Surveying and Mapping attending the Eleventh Annual Meeting hereby express their appreciation to Alfred C. Stiefel, General Chairman, Annual Meeting; to the members of the Program Committee; and to all those whose services have contributed to making this a successful meeting.

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Publications Committee Report

(Presented at the Eleventh Annual Meeting)

During the past 3½ years that the present Publications Committee, of which I had the honor of being chairman, has served, the membership of the Congress has increased from about 1,000 to 2,500, and it is still growing.

So, at the beginning of the year and owing to the increasing pressure of other activities, I asked President FitzGerald to relieve me of the chairmanship, and at the same time urged the Board of Directors to make a study of our publication policy and to give consideration to additional printed media by which to disseminate news of surveying and mapping to the growing membership. The president immediately appointed a committee to investigate the situation and prepare a report indicating what could be done along this line, and the program will no doubt be explained to you later.

The task of a publications committee for an organization such as the Congress, with its diversified, yet allied, interests and activities, is no small task. The property surveyors want to have lots of articles on surveying; cartographers want to read about the latest techniques in their profession; members of the Control Surveys Division want their own activities described and discussed. This all

sums up to the fact that the greatest problem of the Publications Committee is to obtain and furnish to the Editor-in-Chief sufficient papers of wide-enough scope so that he can properly balance the contents of the Journal in line with the demands and interests of the Technical Divisions. This the new committee will continue to do, but it needs your help. Proper balance and variety of the articles in SURVEYING AND MAPPING can be maintained only if the members of the various Technical Divisions prepare and furnish articles from which the Editor can select. So please get busy.

In conclusion I would like to thank the members of the committee—Warren Crump, Wm. Cude, R. E. Frierson, George Whitmore, A. O. Quinn, W. H. Simonson, Jacob Skop, A. A. Stanley, Arthur Striker, and H. W. Whitlock—for the support and cooperation they have given me. It is solely through the effort and time that they gave in editing manuscripts and preparing articles for publication that the committee has been able to function successfully. I understand that the appointment of members of a new committee has been made by the chairmen of the Technical Divisions.

To our Editor-in-Chief, A. L. Shalowitz, I also express my thanks. It has been a pleasure to work with him and I know that the Journal will continue to measure up to the high standards he has set.

HELMUTH BAY
Chairman

Topography Division Report

Northern California Local Section.—Vernon Seward, of the U. S. Geological Survey Sacramento Office, was appointed a member of the Topography Division Membership Committee in 1950. Working with Captain Borden he secured 65 signed applications between October 1 and December 31. In December, he and some of his associates organized a group to discuss articles appearing in the Journal, surveying and mapping problems, and ways and means of helping achieve the objectives of the Congress.

This group has met monthly, and has usually one or more prepared talks, in addition to business meetings and group discussion. As one item of business, they explored the sentiment, not only of their group, but also of all known Congress members in the area, on whether they should attempt to organize as a Local Section. At the last meeting, June 5, it was voted to proceed with the organization, and a petition was prepared, signed by 135 Congress members or applicants for membership, and sent to the Executive Committee of the Congress. (Approved by Board of Direction of the Congress on June 18, 1951.)

This seventh meeting of the group was attended by 52 members and 38 guests. In 10 minutes, Mr. Seward received 22 applications for membership, probably the fastest 10-minute growth in our record. These 22 applicants are in addition to the 65 previously mentioned. The latest available count shows that there are 168 paid-up Congress members in Northern California. With the 22 applicants, there will be 190; 135 of them are actively supporting this group.

Membership Records.—At the same time that Mr. Seward was appointed, C. W. Buckey, Arlington Office, Lloyd E. Marsden, Rolla Office, and R. H. Moore, Denver Office, of the U.S. Geological Survey, were also requested to look for new members. There is no record of the number sent in as a result of Mr. Moore's efforts, but there were several. Mr. Marsden's 56, reported in the April-June

1951 issue of the Journal, increased to 104 before his drive was completed. Mr. Buckey, in an area already containing a large number of members, secured 42 new applications.

Division Membership.—When the Topography Division was reactivated in 1949 there were 57 cards on file in the Secretary's office that indicated Topographic Surveying and Mapping preference. By the time of the Tenth Anniversary Meeting, Division membership had increased to 165. In the recent Division election of officers, 481 ballots were mailed. The officers of the Division are duly grateful to all of these for their support, but they believe that there are many other Congress members who, if they expressed any preference, would also be in this Division. In the records of the Secretary-Treasurer of the Congress only about one-third of the members indicate positive Division preference; two-thirds have neglected or forgotten to mark their dues notices. We believe that each Division should urge that every Congress member be sure he is affiliated with one or more of our six Technical Divisions.

C. S. MALTBY
Chairman

Cartography Division Report

The first meeting of the Cartography Division in 1951 was held January 18, Chairman R. J. Voskuil presiding. The chairman appointed the following officers and chairmen, confirmed by the Board of Directors:

Officers

G. B. Littlepage, *Vice Chairman*
N. E. Greenawalt, *Secretary-Treasurer*
A. F. Striker, *Associate Editor*

Committee Chairmen

W. E. Davies, *Program*
J. P. Dunich, *Membership*
C. F. Fuechsel, *Research-Department*
M. S. A. Delaney, *Technical Standards*

Six meetings were held during the half year, directed towards accomplishing the objectives of the committees and arranging a program for the Division's participation in the Annual Meeting.

In addition, the Division sponsored its first local evening meeting on April 5. Approximately 250 ACSM members and guests residing in the Washington area turned out to hear Dr. John O'Keefe's paper "Curved Space in Two Dimensions." The paper was most ably presented by Dr. O'Keefe's colleague, Bernard Shauvitz.

Helmuth Bay, Washington representative of Rand-McNally Co., gave a most interesting account of the development of the modern road map. At the conclusion of the papers, a color film on "How to Make a Good Impression," dealing with the story of modern lithography, was presented through the courtesy of Harris-Seybold Company.

Because of the enthusiasm evidenced at this meeting, similar meetings are planned for the fall and winter, with the probability of joint sponsorship with other Divisions of the Congress.

R. J. VOSKUIL
Chairman

NEW MEMBERS

ADAM, HAROLD E., U. S. Geological Survey, Box 133, Rolla, Mo.

ALEXANDER, EARL L., Surveyor, Surveyor's Office, La Porte, Ind.

ALLRED, EDGAR L., U. S. Geological Survey, Box 133, Rolla, Mo.

ATKINSON, CHARLES W., Civil Engineer, 3221 Montrose St., Houston, Tex.

ATKINSON, E. S., 745 1st National Bank Bldg., Houston, Tex.

BAIN, JOHN R., Shocco Springs Rd., Talladega, Ala.

BAIRD, WALTER E., 4002 Jefferson St., Hyattsville, Md.

BAKER, CHARLES A., Major, 768—24th Ave., San Francisco 21, Calif.

BAKER, QUENTIN E., U. S. Geological Survey, 2 Rolla Gardens, Rolla, Mo.

BAMFORTH, CHESTER A., Surveyor, 101 Frank St., Norfolk, Va.

BAPTIST, ALVIN J., Station 14, Guam, Guam

BARTLEY, ROBERT J., Civil Engineer, 128 W. Main St., Bay Shore, N. Y.

BEYER, HERBERT O., Field Engineer, Teas & Steinbrenner, Bank Bldg., Malverne, N. Y.

BJORGUM, KERMIT T., 123 S. Mill St., Fergus Falls, Minn.

BODDEKER, R. E., San Jacinto Blue Print Co., 1213 Fannin St., Houston, Tex.

BOND, FRANK C., Land Surveyor, 9 W. Putnam Ave., Greenwich, Conn.

BOUTWELL, JOHN WESLEY, JR., 25 Boston Ave., Takoma Park, Md.

BROWN, JOE L., U. S. Geological Survey, #7 Green Acres, Rolla, Mo.

BROWN, WILLIAM W., JR., U. S. Geological Survey, 507 E. 14th St., Rolla, Mo.

BROWNLEE, JOHN H., Houston Lighting & Power Co., Houston, Tex.

BUNKER, HAROLD, P. O. Box 37, Merrick, N. Y.

BURTON, STANLEY G., 4006 Natasha Dr., Lafayette, Calif.

CASSELL, FRANK B., Pennsylvania Water & Power Co., Holtwood, Pa.

CHAMBERS, ROBERT H., Civil Engineer and Land Surveyor, R.F.D. #4, Rockville, Conn.

CHANG, WEN-HAN, 301 College Ave., Ithaca, N. Y.

CHAPPELL, W. G., Dinwiddie, Va.

CHERRY, ALONZO L., U. S. Engineer Office, P. O. Box 119, Norfolk 1, Va.

COGLIANDRO, RICHARD J., Land Surveyor, Teas & Steinbrenner, Bank Bldg., Malverne, N. Y.

COKER, C. P., Engineer and Surveyor, Florida State Road Dept., P. O. Box 682, Arcadia, Fla.

COLE, M. B., Manager, Houston Blue Print & Stationery Co., 140 Esperson Bldg., Houston, Tex.

COLLINS, JOHN G., U. S. Geological Survey, 2248 Marconi Ave., Sacramento 15, Calif.

COX, SETH R., U. S. Geological Survey, P. O. Box 346, Sacramento, Calif.

CRAWFORD, W. A., Surveyor, College Park, Staunton, Va.

CROSS, GARTH M., Box 375, Manhattan Beach, Oreg.

CROUCH, GLENN O., 3481 Sierra View Lane, North Sacramento 15, Calif.

CRUISE, R. B., Engineer, Gulf States Utilities Co., Box 2951, Beaumont, Tex.

CUMBOW, A. L. JR., P. O. Box 305, Abingdon, Va.

CURRAN, JOHN EDWARD, Civil Engineer and Land Surveyor, Rm. 203, Title Insurance Bldg., Reno, Nev.

CUSTIDERO, LOUIS R., 6018—9th Rd. N., Arlington, Va.

D'ANDREA, ROCCO V., Surveyor, Boston Post Road, Riverside, Conn.

DAVIS, DALE V., c/o Chas. H. Swift Co., Box 1087, Dodge City, Kans.

DeBEAU, EDWIN B., Civil Engineer, 15 Thorne Ave., Hempstead, N. Y.

DEMAREST, L. B., 17 Wakefield Pl., Caldwell, N. J.

DESMOND, W. E., JR., St. Paul, Va.

DETJEN, RICHARD F., U. S. Geological Survey, 100 S. Elm St., Rolla, Mo.

DICKSON, JOHN H., Surveyor, 8 Harriet Ct., Sea Cliff, N. Y.

EARLE, TRUMAN R., Surveyor, 1116½ N. Western Ave., Los Angeles 29, Calif.

EDWARDS, MALCOLM B., 1119 Water St., South Bend, Wash.

EGNER, CARL A., Prof., 1308 Ravinia Rd., West Lafayette, Ind.

EGOLF, HARRY L., JR., 203 Tiburon Blvd., San Rafael, Calif.

EHRHARDT, W. E., Land Surveyor, Box 191, Baytown, Tex.

ELDER, E. K., Land Surveyor, P. O. Box 418, Albuquerque, N. Mex.

ELKINS, FRANK S., U. S. Geological Survey, 1400 N. Buchanan St., Arlington, Va.

ESLINGER, THOMAS R., 110 Willamette Ave., Medford, Oreg.

EUBANKS, REUBEN W., U.S. Geological Survey, 110 S. Walker St., Rolla, Mo.

EVANS, ARTHUR R., 748 S. Pine St., Roseburg, Oreg.

FAIRFIELD, GEO. A., Civil Engineer, Denton Bldg., Mineola, N. Y.

FLOYD, BENNY, P. O. Box 194, Enumclaw, Wash.

FOGG, PATRICIA L., U.S. Geological Survey, P. O. Box 346, Sacramento 2, Calif.

FREEMAN, PHILIP D., Consulting Engineer, 4901 Colley Ave., Norfolk, Va.

GADDY, JOSEPH H., U.S. Geological Survey, Box 102, Newburg, Mo.

GIBB, JOSEPH B., County Surveyor, Accomack County, Accomac, Va.

GINTER, EDWIN L., U.S. Geological Survey, Box 133, Rolla, Mo.

GODFREY, ELIZABETH M., 2150 Pennsylvania Ave., N. W., Washington 7, D. C.

GOETZE, KLAUS F., Surveyor, 6616 Leland Way, Los Angeles 28, Calif.

GRAHAM, BENJAMIN H., Land Surveyor, 967 Harrison St., Monterey, Calif.

GREEVER, JOHN J., Civil Engineer, Route #1, Box 145, Melbourne, Fla.

GREGG, FERRELL L., U.S. Geological Survey, 3630 W. Alice Pl., Denver, Colo.

GREGORY, HENRY W., Land Surveyor, 433 Main St., Stamford, Conn.

GROVER, JOHN F., 3585 Merrick Rd., Seaford, N. Y.

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